

Landsat Science Team

Landsat Operations Report

22 July 2014

Brian Sauer

USGS, Landsat Sustaining Engineering Project Manager

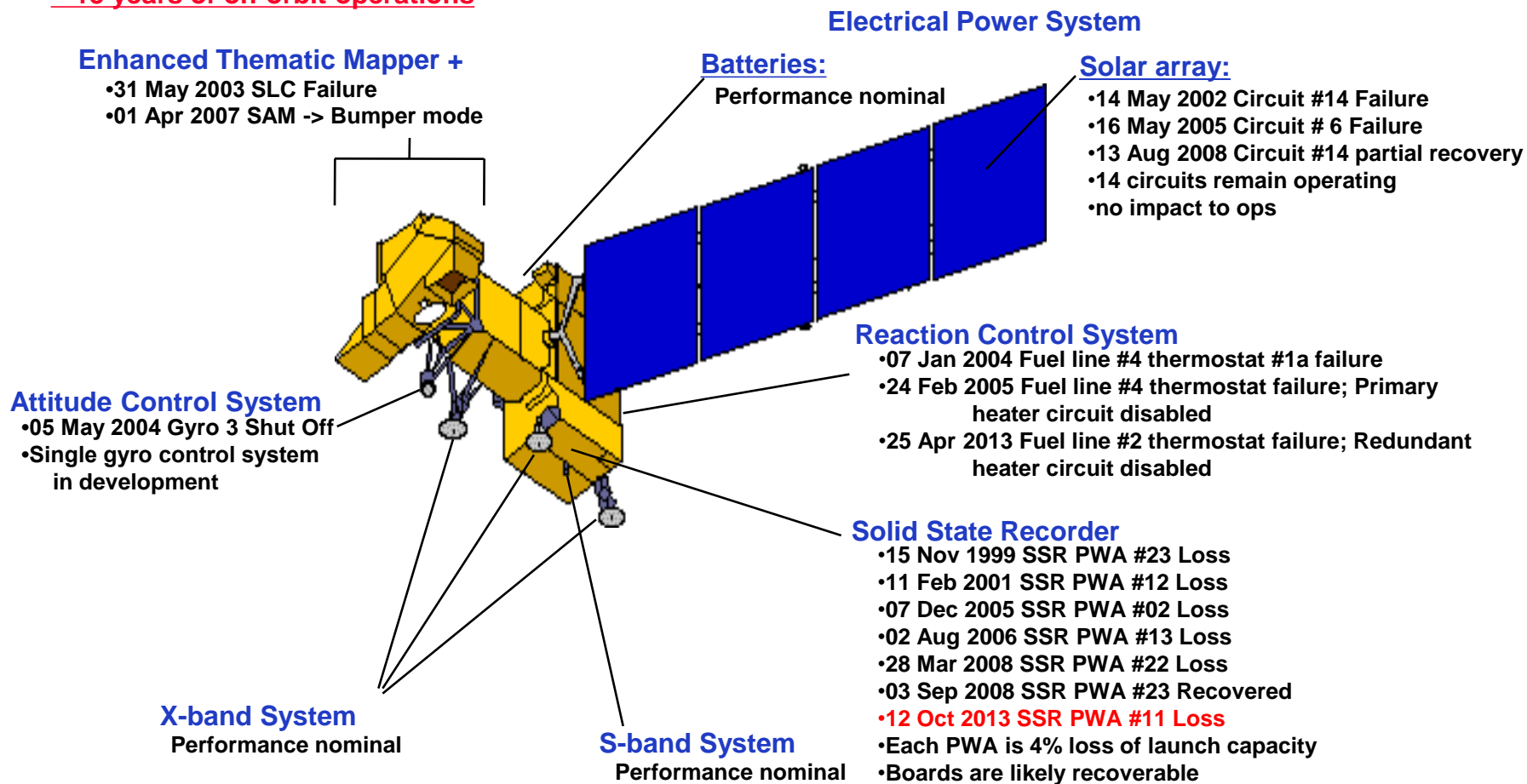
bsauer@usgs.gov, (605) 594-2587

Agenda

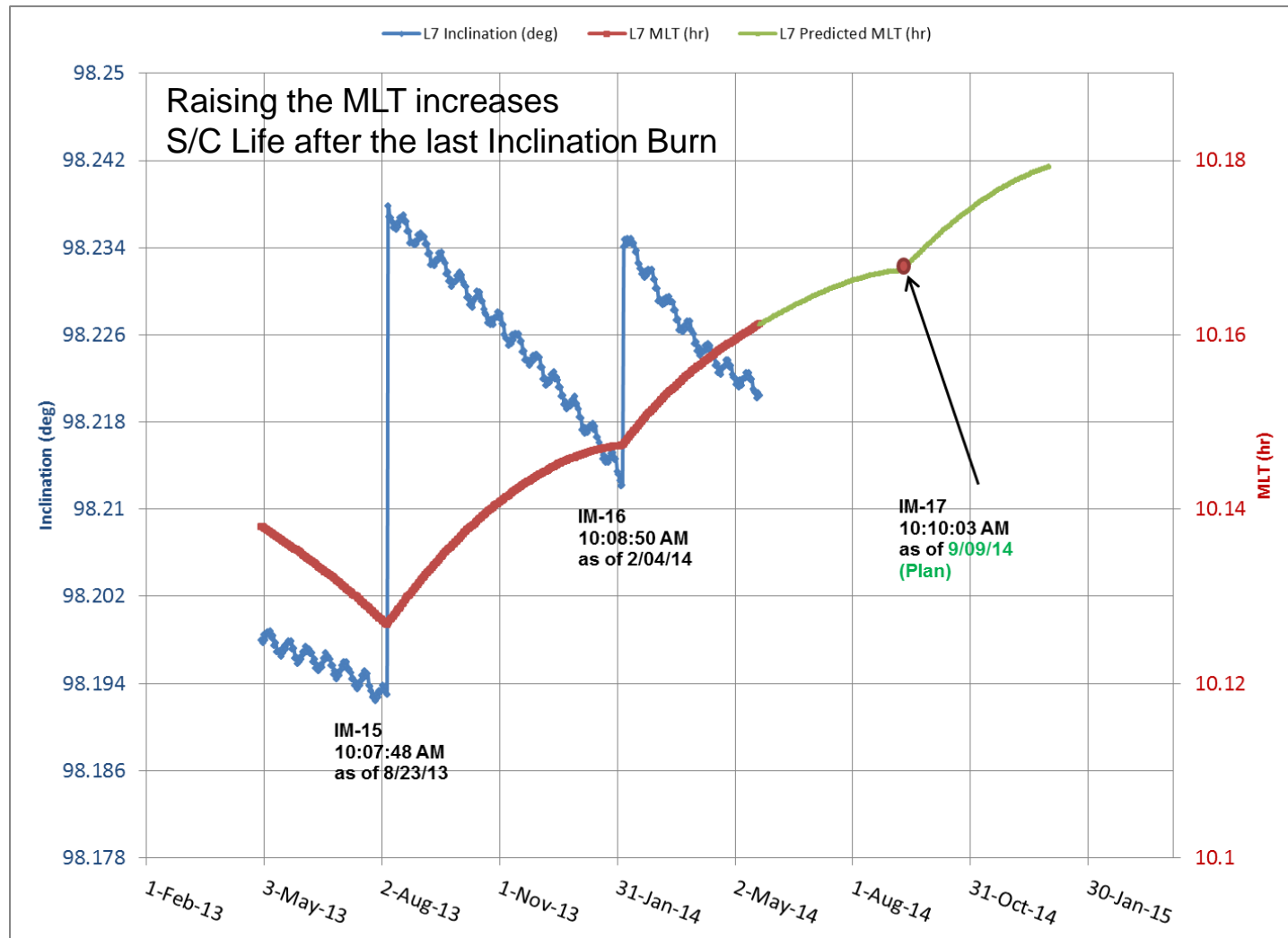
- **L7 Status**
- **L8 Status**
- **Data Acquisition Update**
- **LGAC Update**
- **Level 1 Data Production Improvements**
- **Archive and Distribution Metrics for Reference**

Spacecraft Status: Summary

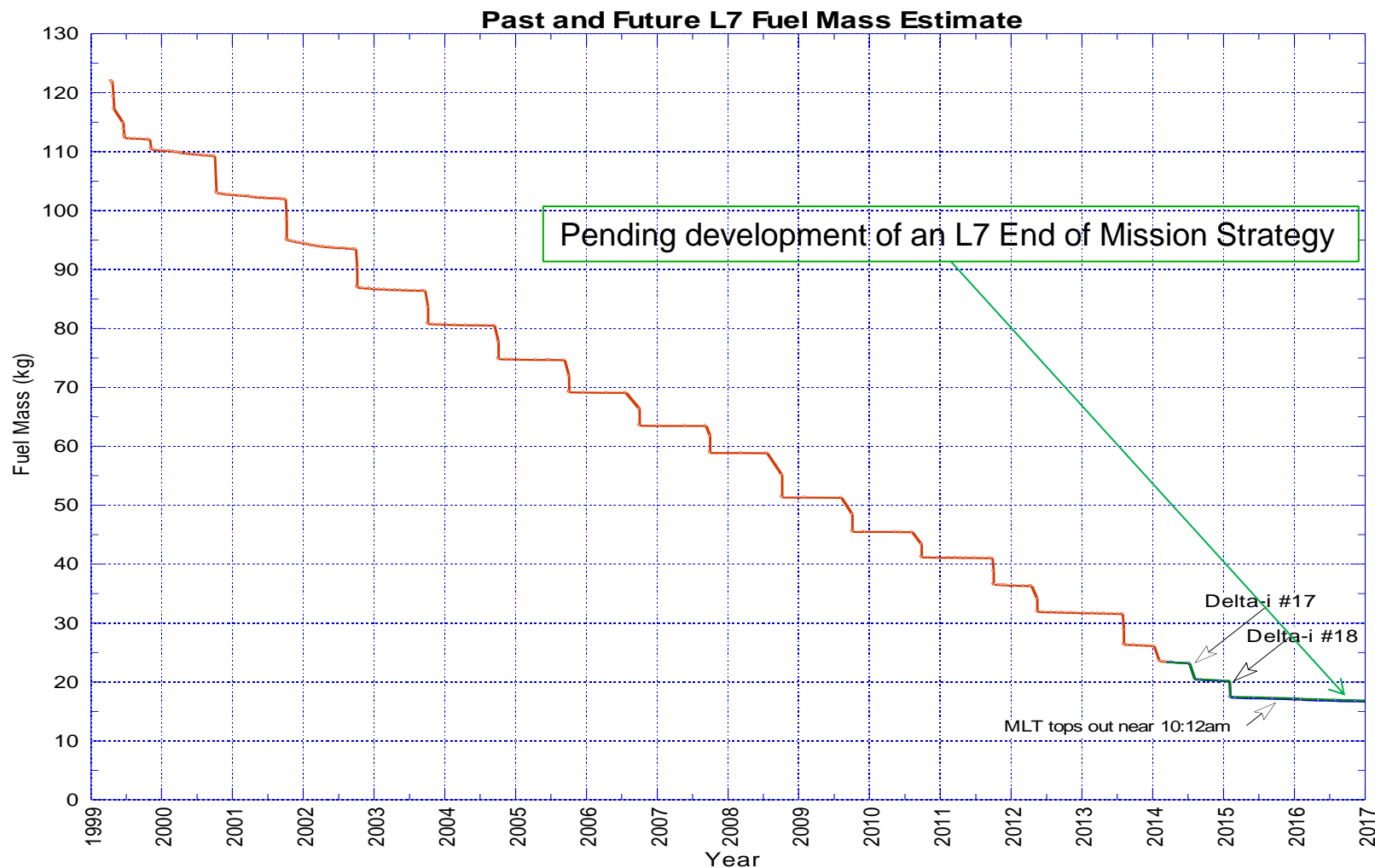
~ 15 years of on-orbit operations



L7 Mean Local Time and Inclination



Fuel Usage and Prediction

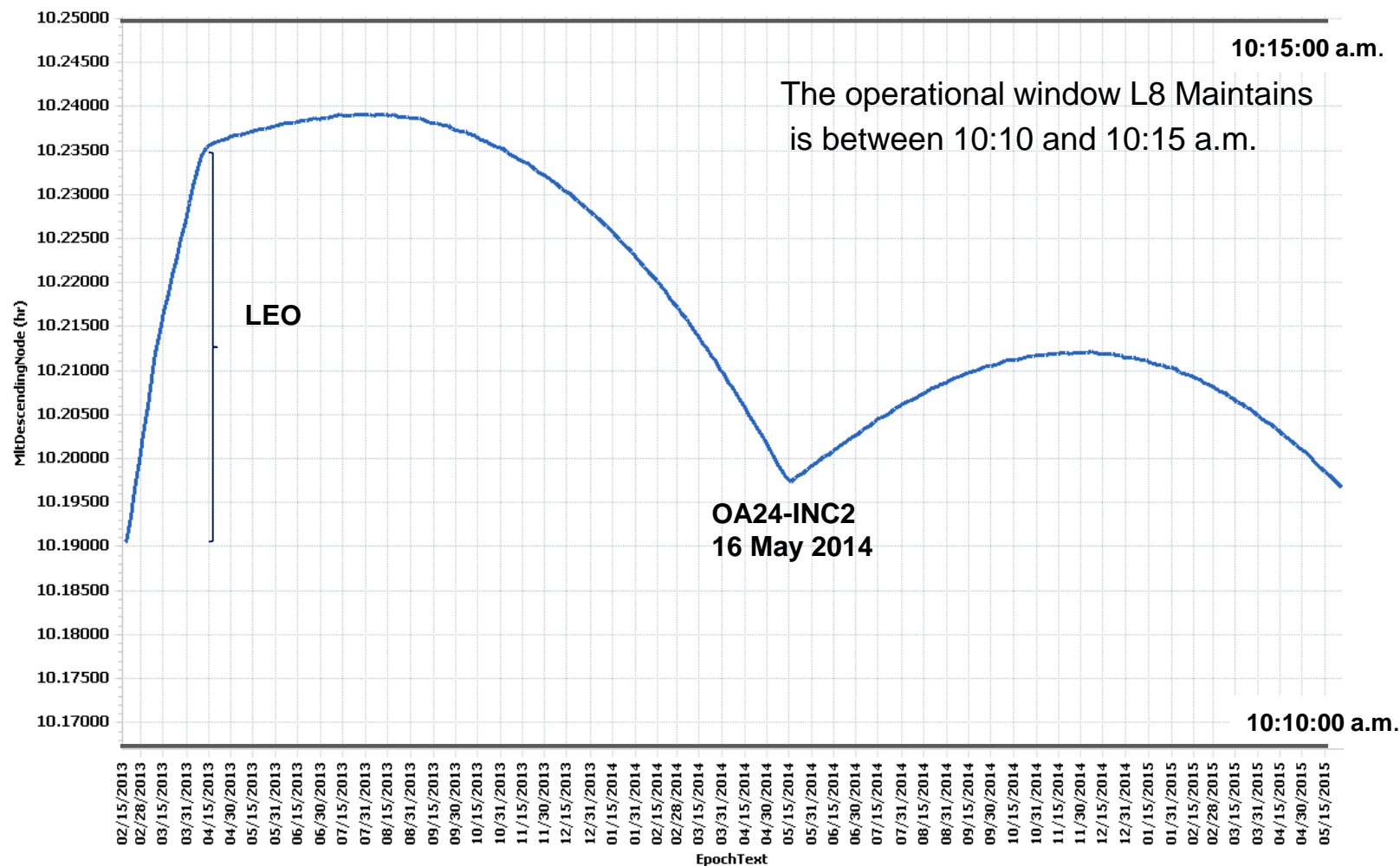


Landsat 8 Spacecraft Status



All systems good

L8 Mean Local Time



Activity Summary/Payload Performance/Anomalies

- **Sun Acquisition Safe Hold Event**
 - **DOY 262 – 19 Sep 2013**
 - **Landsat 8 spacecraft performed an ACS safehold response, per design, for an attitude control error condition**
 - **A deviation from the routine Ops Con (one lunar calibration per month) was made in order to add an additional lunar calibration to gather data on TIRS lunar ghost artifacts**
 - **In Summary: A lunar calibration requires a special file to drive the spacecraft slew profile. Because we attempted 2 calibrations, the second file was loaded before the first scan started. This resulted in the spacecraft slewing to the wrong place tripping the attitude alarms.**
 - **40 hours recovery time to return to science collection**

Activity Summary/Payload Performance/Anomalies

- **Coarse Earth Safehold Event**
 - **DOY 119 – 29 Apr 2014**
 - **Landsat 8 spacecraft performed an ACS safehold response, per design, for a projected solar incursion into the instrument bore sight FOV**
 - **The event occurred during an extended eclipse period due to a moon shadow event - a very unusual geometry**
 - **In Summary: The Coarse Sun Sensors could not definitively determine the attitude of the spacecraft, so as designed, the spacecraft placed itself in a safe attitude with the instruments protected**
 - **38 hours recovery time to return to science collection**

Long-Term Acquisition Plan

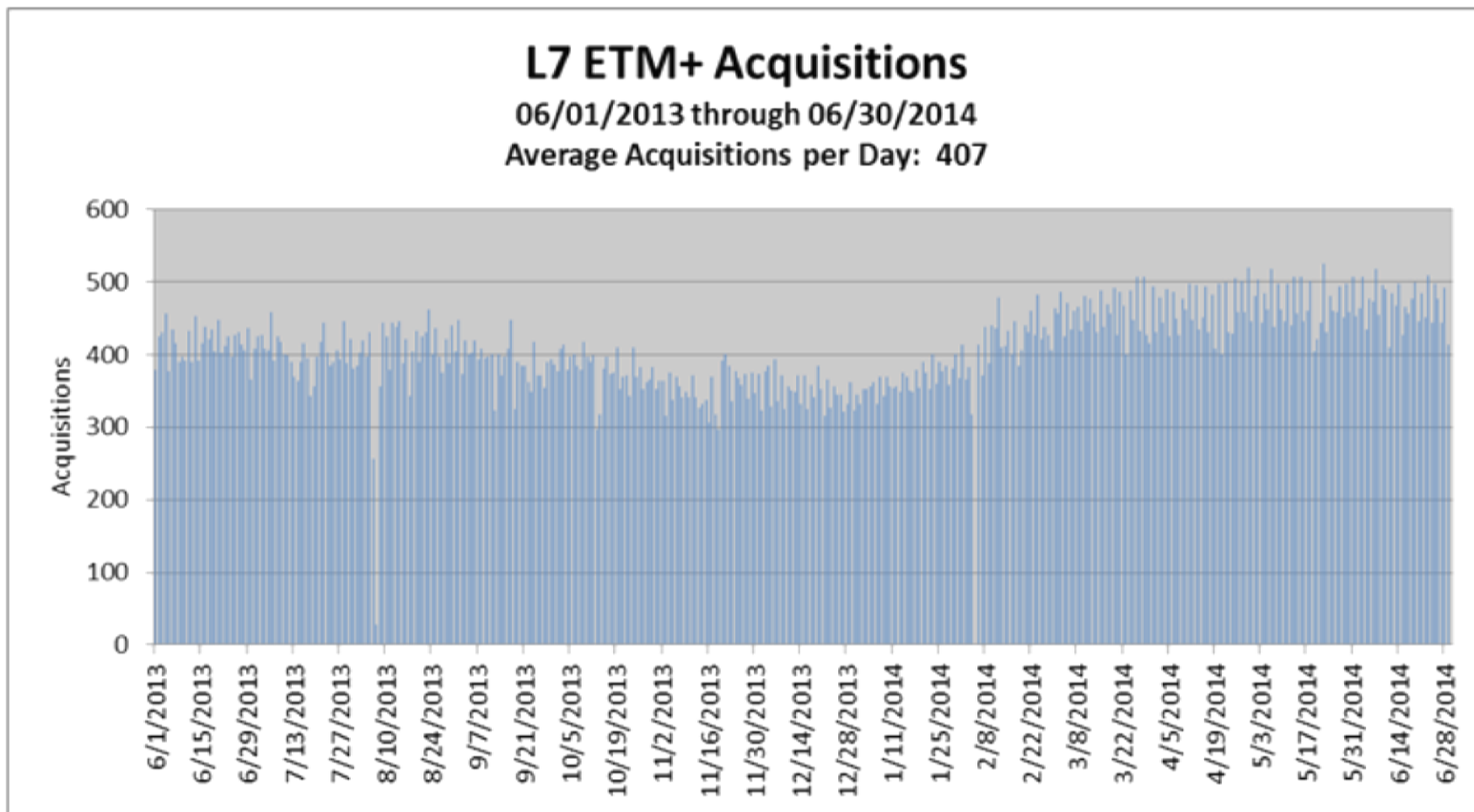
Constraints

- Landsat 7
 - ◆ Daily limit constraints have been removed
 - ◆ Duty cycle constraints
 - ◆ Storage capacity constraints
 - ◆ Sun-lit land and descending scenes
 - ◆ Managing ETM+ duty cycle and power cycles to extend mission life
- Landsat 8
 - ◆ Solid state recorder facilitates global acquisition of images
 - ◆ No health and safety constraints on day-lit imaging
 - ◆ Cost constraints on downlinks, processing and archive
 - ◆ Physical constraints currently limit night imaging

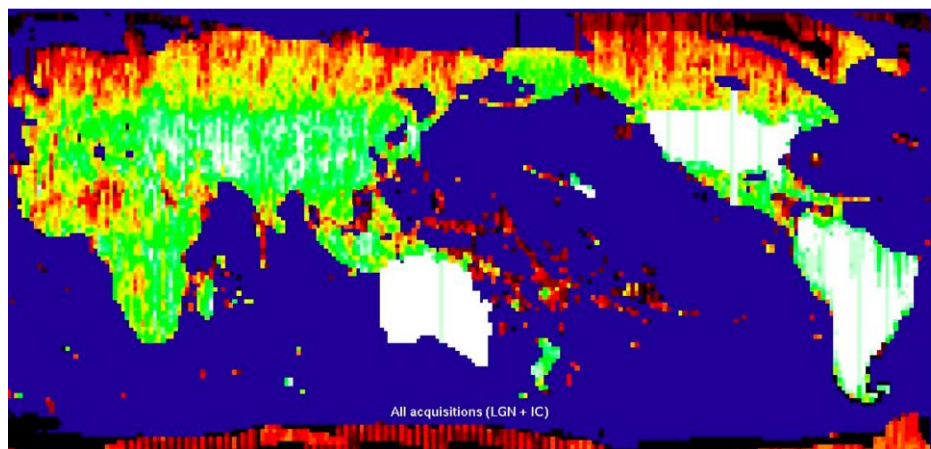
Science imaging

- Landsat 7
 - ◆ Reduced imaging of islands, water and Antarctica
 - ◆ Increased imaging of continental land masses
 - ◆ Acquire average of 438 images/day
 - ◆ Limited night imaging – best thermal sensor
- Landsat 8
 - ◆ Acquire 550 or more images per day
 - ◆ Cloud prediction threshold: 98% or higher
 - ◆ Decreasing priority ramp in polar zones proportional to sidelap
 - ◆ Increase Arctic & Antarctica acquisitions
 - ◆ Support large water campaigns
 - ◆ Higher island priority
 - ◆ Support ascending node day campaigns
 - ◆ Support limited night special requests (such as, urban heat island, fires and volcanoes)

Landsat 7 Acquisitions

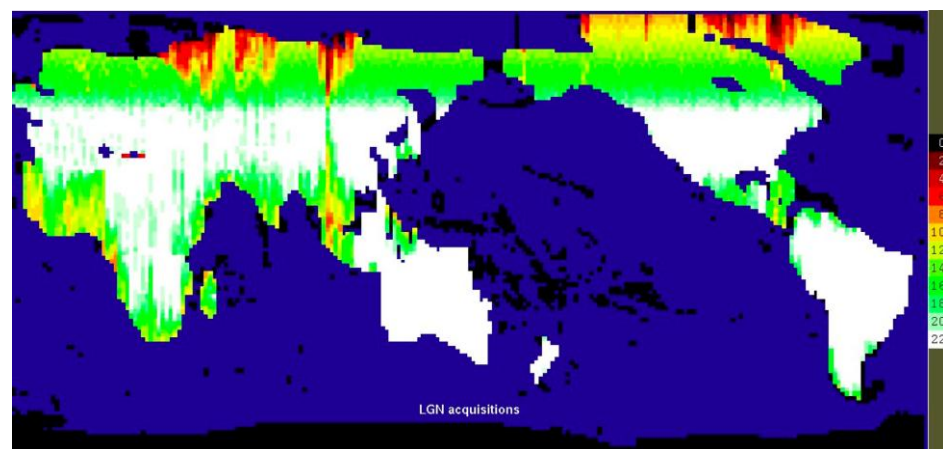


Landsat 7 Continental Model



Prior to Continental Model

- Areas in white are always acquired
- NH Summer Average: 482 images/day of 550 opportunities
- NH Winter Average: 357 images/day of 358 opportunities

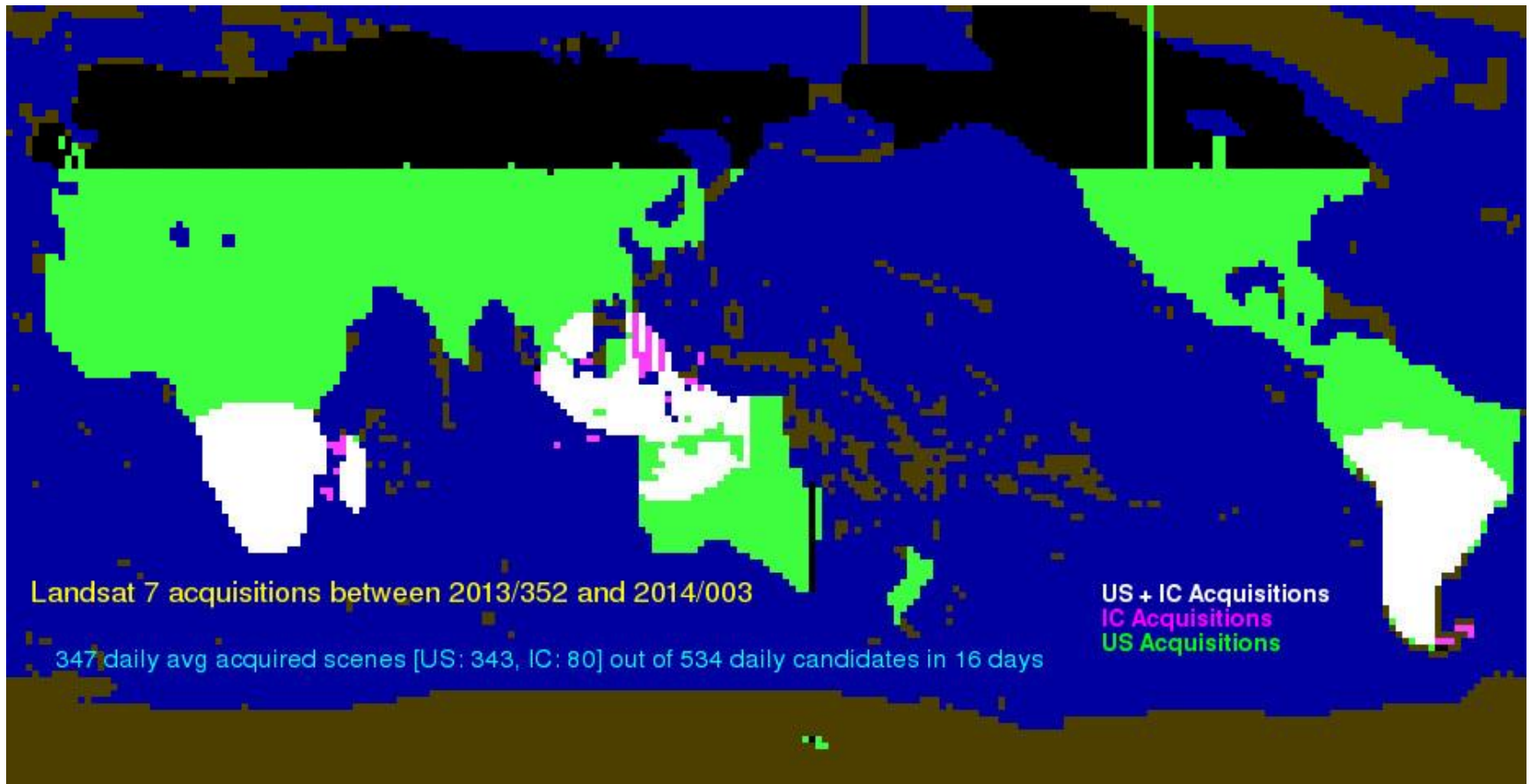


Modeled one-year global coverage

Daily Average Metrics	Continental Model	Prior to Continental
Qualifying Candidate Scenes	479 scenes/day	536 scenes/day
Acquisition Rate (LGN)	438 scenes/day (91% of candidates)	375 scenes/day (70% of candidates)
ETM+ duty cycle	14.40%	15.10%
ETM+ power cycles	17.5	28.6
Average ACCA	47.5	37.3
Clear scene acquisition rate (ACCA ≤ 10)	129 scenes/day (29% of acquisitions)	126 scenes/day (34% of acquisitions)
Marginal scene acquisition rate (ACCA ≤ 50)	230 scenes/day (53% of acquisitions)	238 scenes/day (64% of acquisitions)

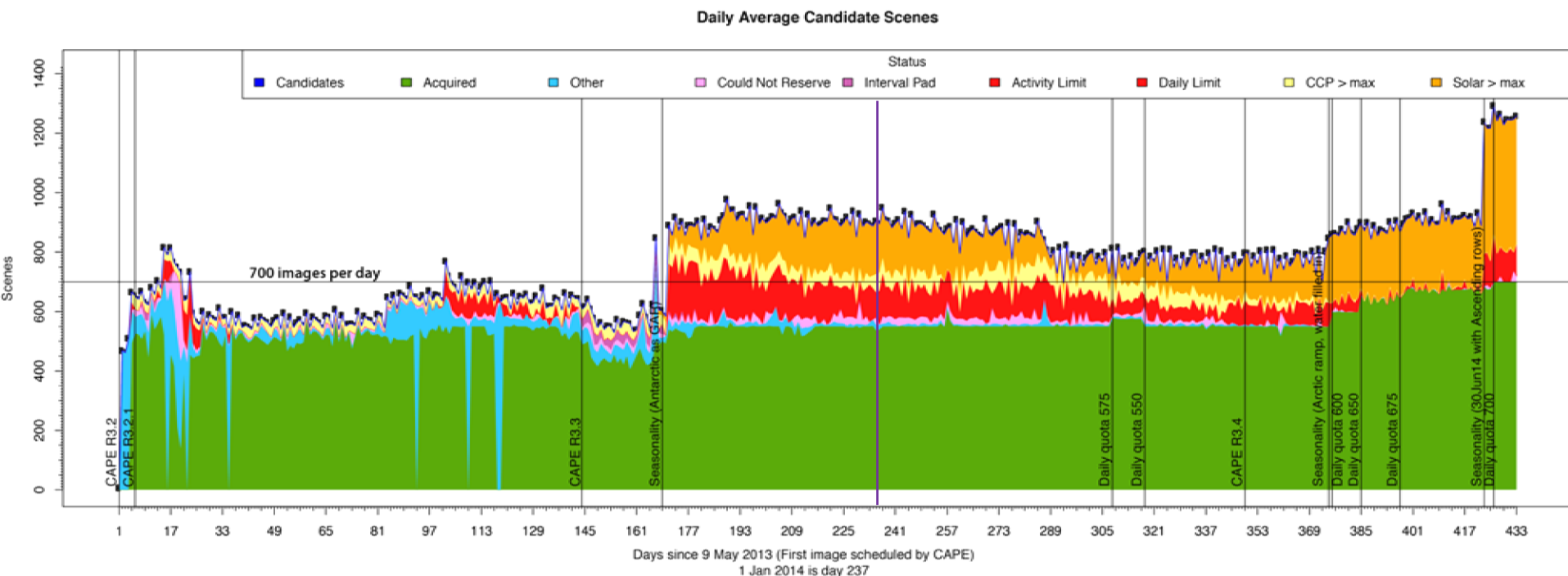
Constraints Influence Landsat 7 Seasonal Coverage

- No images rejected during NH winter when fewer day-lit opportunities exist
- We are considering increased constraints in the Arctic to yield more imaging in the Tropics



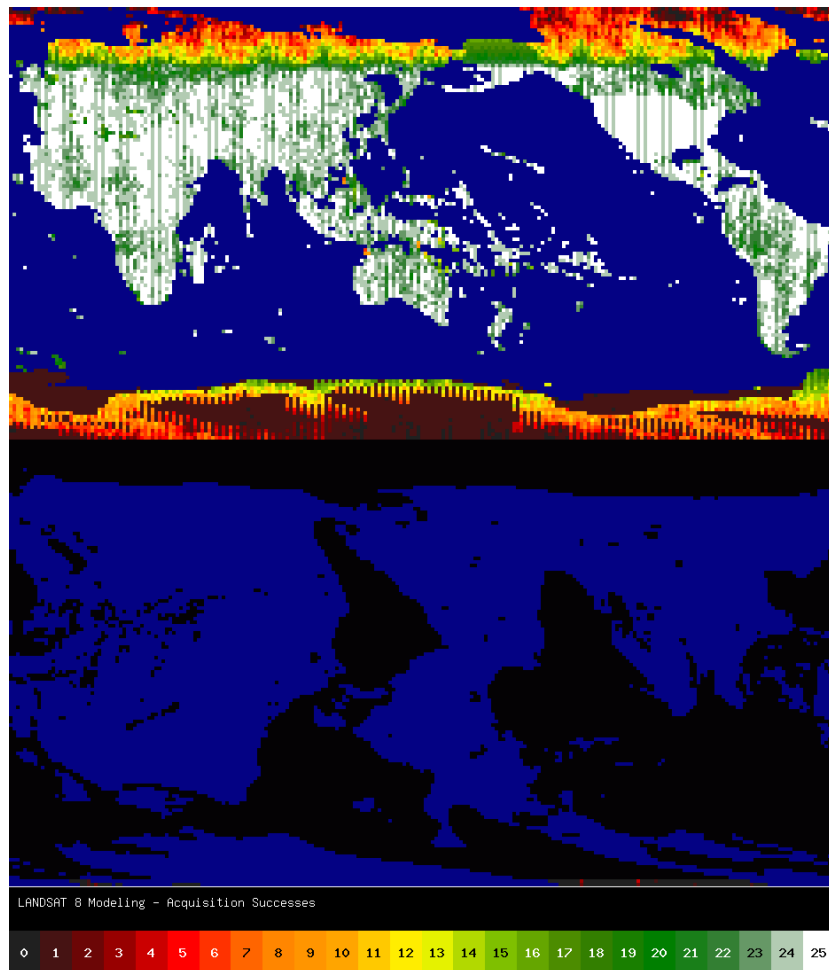
Landsat 8 Acquisitions

- Gold represents scenes rejected due to sunlight
- Red are rejected scenes based on limits
- Yellow are cloud cover rejections

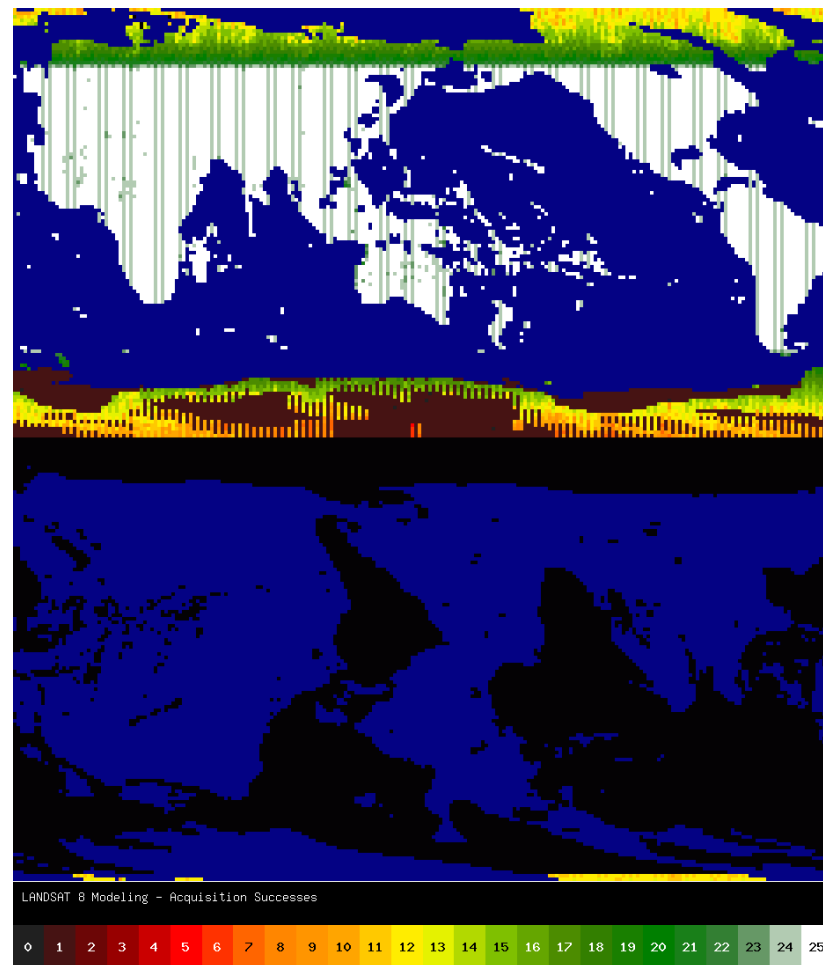


Landsat 8 – Number of Images

550 images/day at 98% cloud threshold



650 images/day at 100% cloud threshold

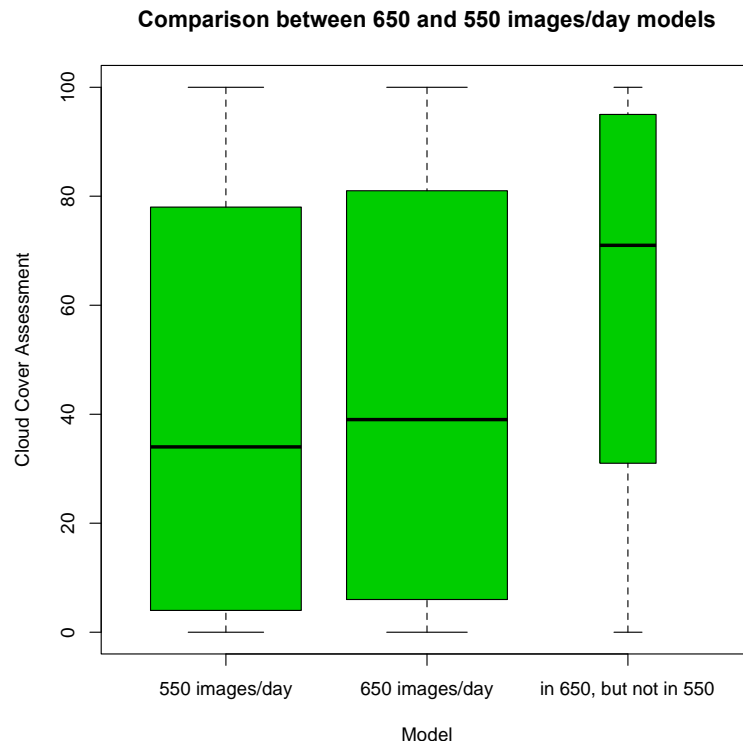


Landsat 8 Daily Limit Investigation

- **During the 2014 Northern Hemisphere Growing Season the daily imaging rate will be gradually increased to establish upper bounds and an optimal daily imaging rate**
 - **Increase from 550 to 600, then to 650 and remove cloud prediction threshold**
 - **Evaluate this increase, then increase in 25 image increments until**
 - ♦ **all day-lit descending land scenes are imaged or**
 - ♦ **constraints are encountered**
- **Use results to establish optimal daily imaging rate for operational imaging**

Landsat 8 550 and 650 model results

- Images acquired by the 650 model and rejected by the 550 model
 - 25% of the acquisitions have an ACCA score of 31 or better
 - 50% of the acquisitions have an ACCA score of 71 or better
 - Or 50 images/day with cloud cover better than 71% are rejected at 550 images/day
- Science requirement for additional 100 images/day
 - Cloud prediction confidence in many persistently cloudy areas (boreal and humid tropics) is low
 - The geometric fidelity of Landsat 8 images permit all data to be coregistered
 - Over time the threshold for acceptable cloud cover in acquired scenes has increased as registration and atmospheric models improved



	Cloud Cover Assessment		
	550 model	650 model	100 difference
1 st Quartile	4	6	31
Median	34	39	71
Mean	41.55	44.01	61.64
3 rd Quartile	78	81	95

Landsat Global Archive Consolidation (LGAC) – June 2014

CANADA (PAC)
Canada Centre for Remote Sensing (CCRS), Natural Resources Canada (NRC)



Victoria Island, Vancouver, Canada
Landsat 5 TM: Path 60 Row 10
Acquired: 7 July 1988
Ingested at EOSS: 22 November 2010

ECUADOR (CPE)
Ecuadorian Center for Integrated Surveys of Natural Resources with Remote Sensing (CUIRSIN)



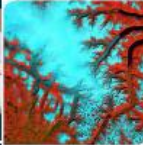
Reserva Natural Delia del Cuzco Real, Manabí
Landsat 5 TM: Path 18 Row 01
Acquired: 5 September 1987
Ingested at EOSS: 21 December 2011

ARGENTINA (COA)
Comisión Nacional de Actividades Espaciales (CONAE)



Arica, Chile
Landsat 5 TM: Path 7 Row 73
Acquired: 20 January 2005
Ingested at EOSS: 17 February 2011

CANADA (GNC)
Canada Centre for Remote Sensing (CCRS), Natural Resources Canada (NRC)



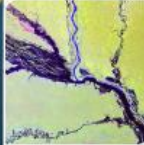
Barfleur Island, Montreal, Canada
Landsat 5 TM: Path 18 Row 13
Acquired: 19 July 1987
Ingested at EOSS: 26 March 2011

PUERTO RICO (UPR)
University of Puerto Rico (UPR), Laboratory of Applied Remote Sensing and Image Processing (LARSIP)



Port-au-Prince Bay, Haiti
Landsat 5 TM: Path 5 Row 47
Acquired: 7 March 1982
Ingested at EOSS: 14 July 2011

BRAZIL (CUB)
Instituto Nacional de Pesquisas Espaciais (INPE)



Amazon River, Brazil
Landsat 5 TM: Path 222 Row 01
Acquired: 18 August 2004
Ingested at EOSS: 25 July 2010

SOUTH AFRICA (JSA)
South African National Space Agency (SANSA)



Cape Town, South Africa
Landsat 5 TM: Path 175 Row 06
Acquired: 6 January 1987
Ingested at EOSS: 17 September 2011

SWEDEN (KIS)
European Space Agency (ESA)




Southern Island
Landsat 5 TM: Path 105 Row 10
Acquired: 9 July 1986
Ingested at EOSS: 13 January 2014

SAUDI ARABIA (RSA)
King Abdullah City for Science & Technology (KACST)



Tahib, Saudi Arabia
Landsat 5 TM: Path 173 Row 01
Acquired: 12 July 1986
Ingested at EOSS: 13 October 2011

PAKISTAN (ISP)
Pakistan Space and Upper Atmosphere Research Commission (SUPARCO)



Bajauristan, India
Landsat 5 TM: Path 156 Row 01
Acquired: 20 November 1991
Ingested at EOSS: 5 May 2011

KYRGYZSTAN (BIX)
Campaign station, courtesy of German Aerospace Center (DLR)



And Sea, Uzbekistan
Landsat 5 TM: Path 161 Row 23
Acquired: 2 September 1986
Ingested at EOSS: 2 June 2011

CHINA (BJC)
Center for Earth Observation and Digital Earth (CEODE)



Chengdu, Xining, China
Landsat 5 TM: Path 122 Row 20
Acquired: 16 November 1987
Ingested at EOSS: 27 May 2012

MONGOLIA (ULM)
Campaign station, courtesy of German Aerospace Center (DLR)



Tongjin, China
Landsat 5 TM: Path 122 Row 23
Acquired: 16 May 1986
Ingested at EOSS: 2 June 2011

JAPAN (HJU)
Nihonshi Institute of Technology (NIT), Hiroshima Earth Environment Information Center (HEEC)



Shimon, Japan
Landsat 7 ETM+: Path 113 Row 16
Acquired: 18 April 2006
Ingested at EOSS: 2 June 2011

JAPAN (HAJ)
Japan Aerospace Exploration Agency (JAXA), Remote Sensing Technology Center of Japan (RESTEC)




Jeju Island, South Korea
Landsat 5 TM: Path 103 Row 27
Acquired: 24 April 1986
Ingested at EOSS: 25 May 2013

TAIWAN (DLT)
Center for Space and Remote Sensing Research (CSRSR), National Central University (NCU)



Taipei, Taiwan
Landsat 5 TM: Path 112 Row 03
Acquired: 6 September 1986
Ingested at EOSS: 7 October 2011

INDONESIA (DIK)
Indonesian National Aeronautics and Space Institute (LAPAN)



Samarang Day, Philippines
Landsat 5 TM: Path 112 Row 06
Acquired: 18 October 1986
Ingested at EOSS: 2 May 2011

AUSTRALIA (ASA)
Geoscience Australia – National Earth Observation (GA-NEO)



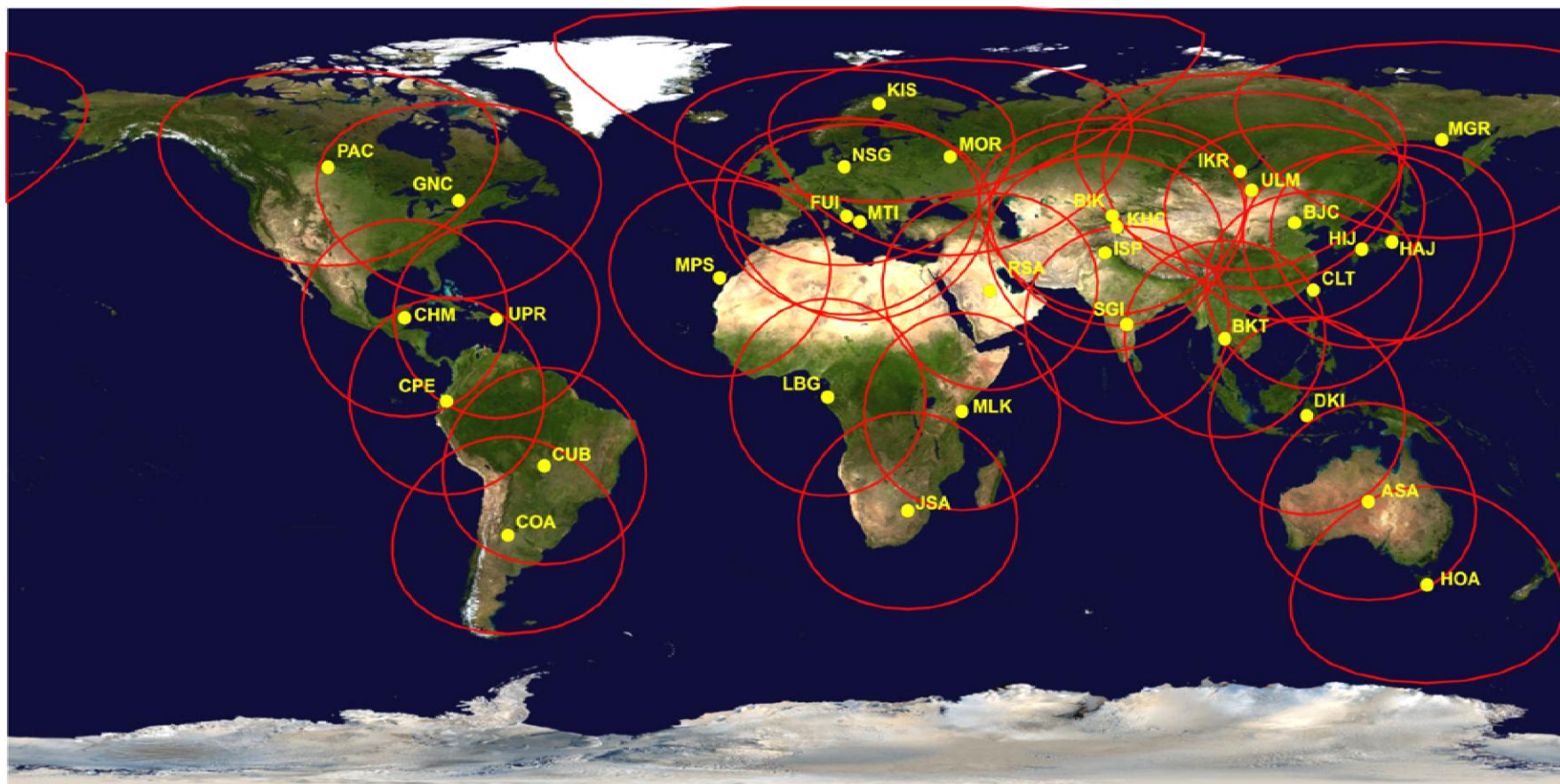
Lake Eyre, Australia
Landsat 5 TM: Path 20 Row 06
Acquired: 13 September 2005
Ingested at EOSS: 2 October 2011

AUSTRALIA (HQA)
Geoscience Australia – National Earth Observation (GA-NEO)



Picton, New Zealand
Landsat 7 ETM+: Path 173 Row 02
Acquired: 27 February 2000
Ingested at EOSS: 26 December 2011

Historical Landsat Ground Stations



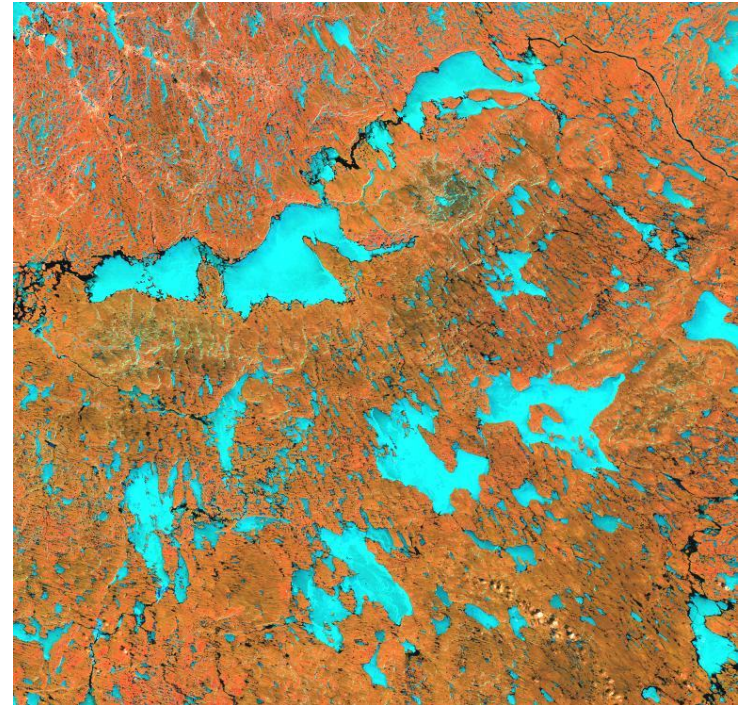
* Does not include Landsat Ground Network (LGN) stations



Landsat Global Archive Consolidation (LGAC)

- Over 3 Million scenes collected as of July 1, 2014
- Previous “Woodcock Metric”:
2,550,354
- Current (7/1/14):
3,025,557

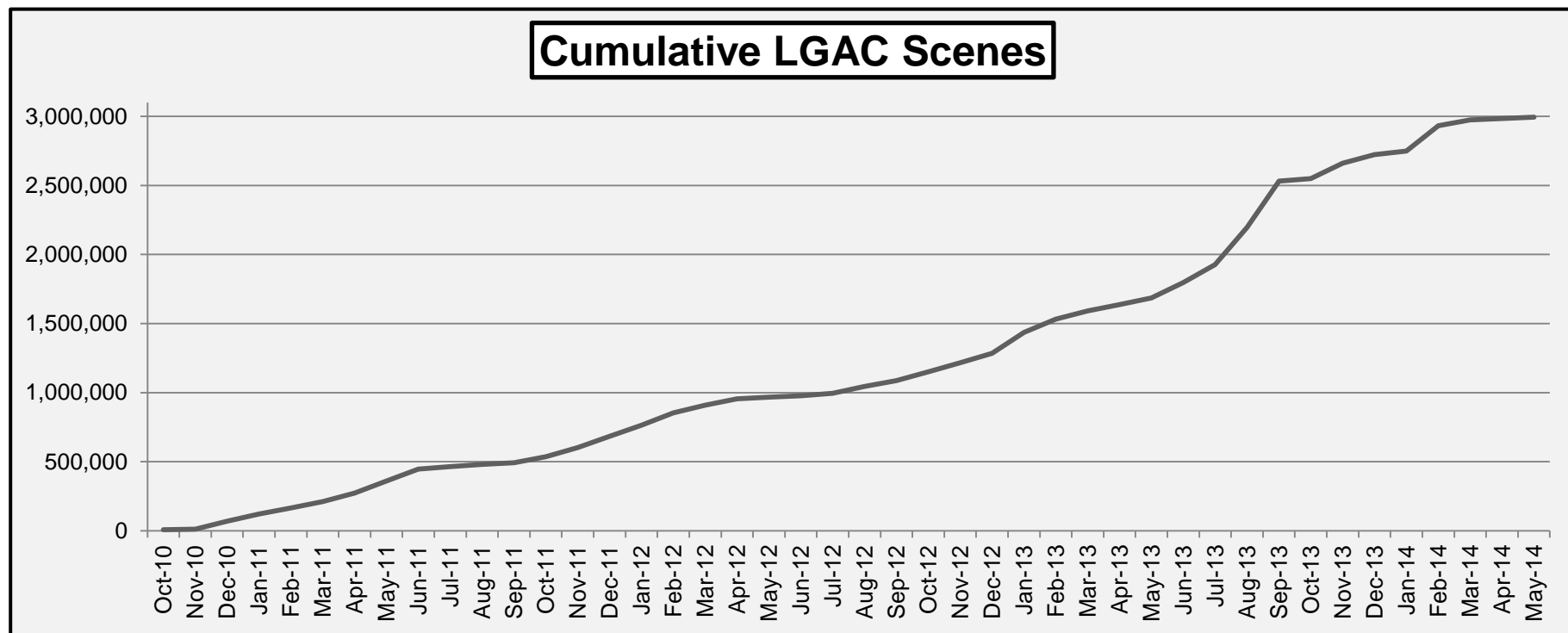
Estimate was initially about 5M total scenes so well over half way there!



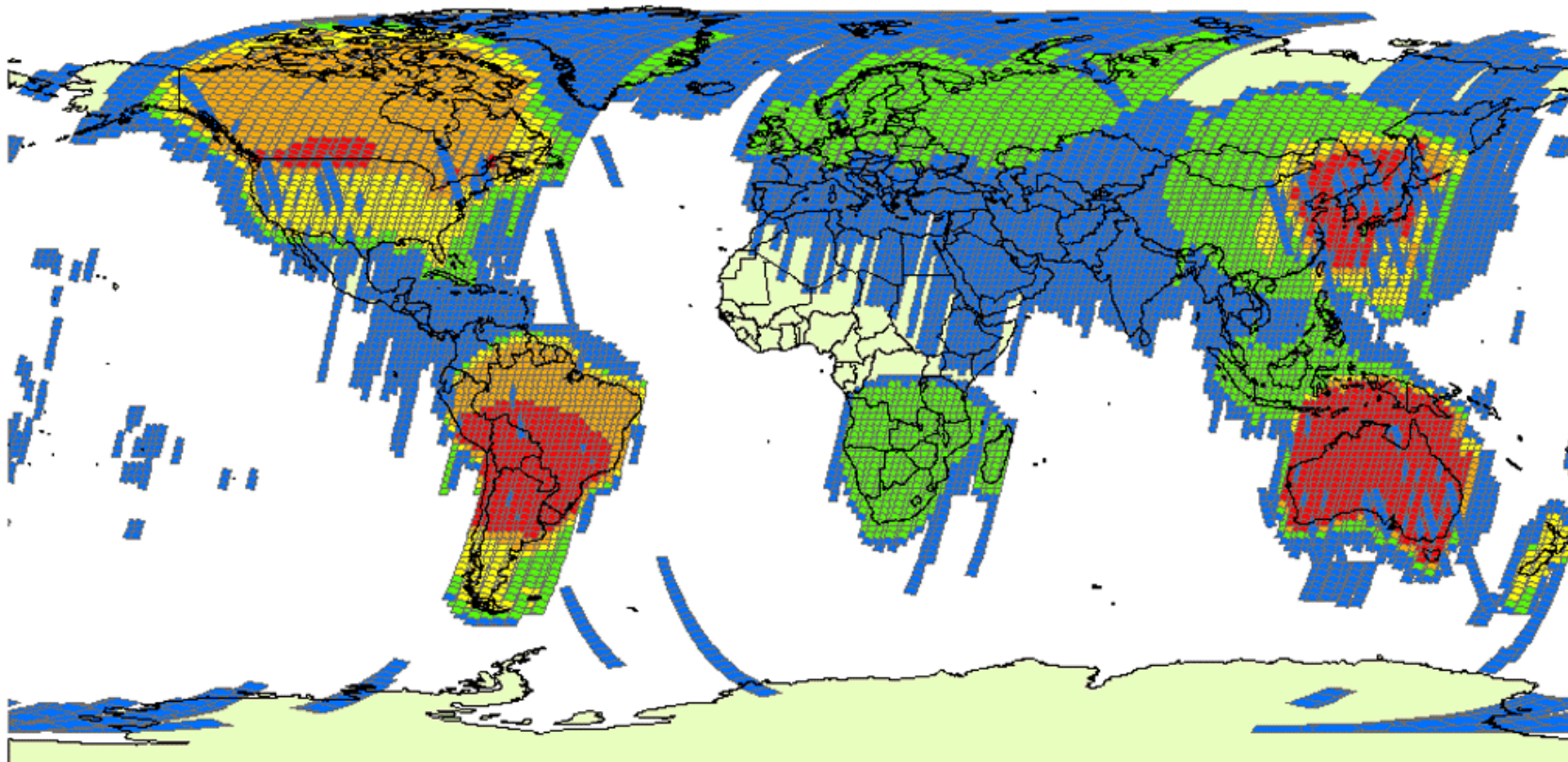
Landsat 5 TM image transcribed from CCRS D-1 tape – available in archive

LGAC Major Accomplishments

Cumulative LGAC Scenes Ingested into the Archive



LGAC Ingest Summary



LGAC WRS2 Scenes

Status as of May 31, 2014

Acquisition Date Range: August 22, 1982 through May 30, 2014

3,021,524 Cumulative Scenes Delivered

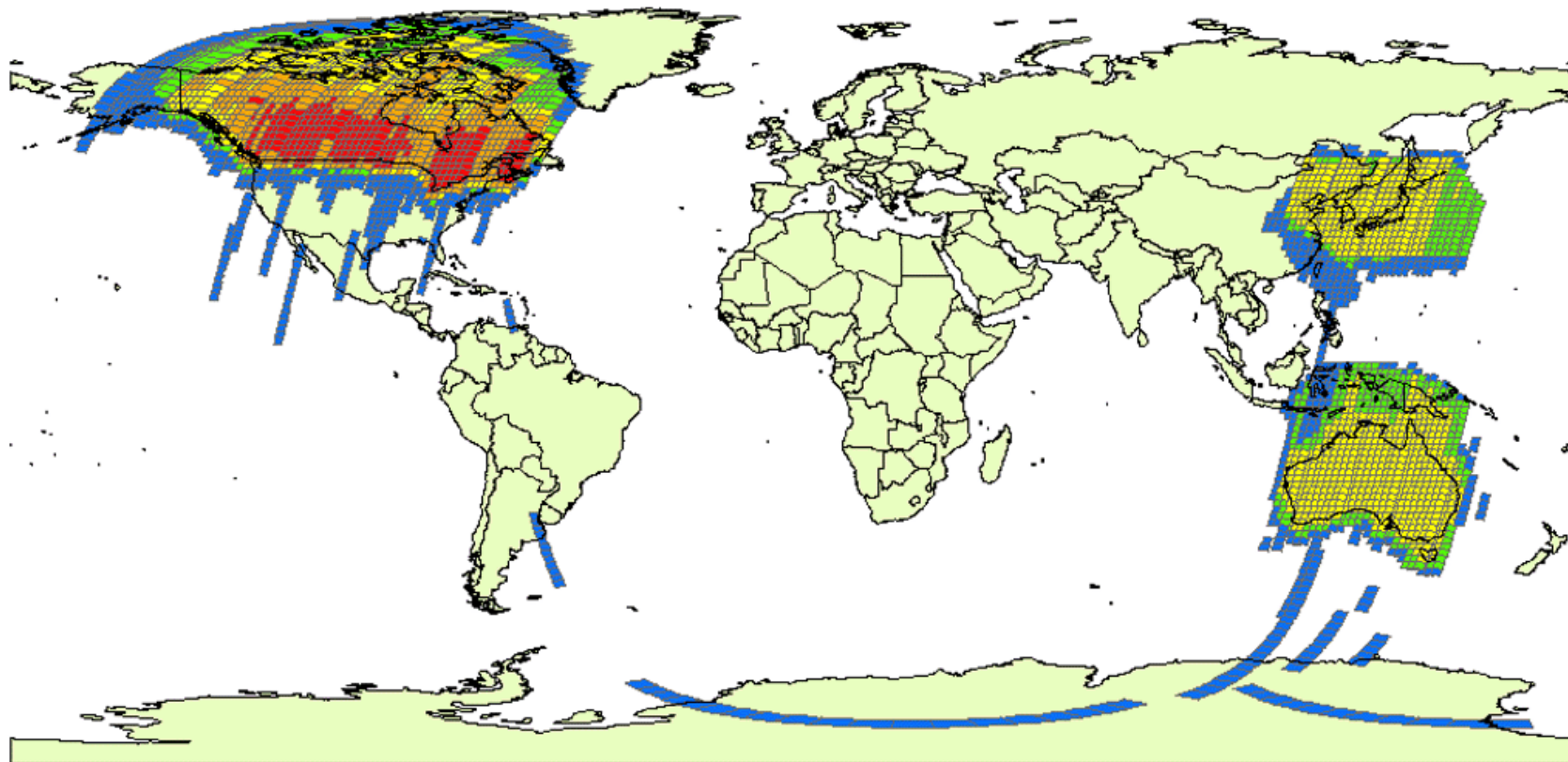
2,856,728 Total WRS2 Scenes Acquired

13,044 Unique WRS2 Path/Rows

1 - 85 86 - 242 243 - 473 474 - 762 763 - 1090



LGAC Ingest Summary



LGAC WRS1 Scenes

Status as of May 31, 2014

Acquisition Date Range: July 26, 1972 through March 31, 1983

3,021,524 Cumulative Scenes Delivered

164,796 Total WRS1 Scenes Acquired

3,521 Unique WRS1 Path/Rows

1 - 20 21 - 44 45 - 67 68 - 94 95 - 135



LGAC Status

Country (Organization)	Ground Station	% LGAC Delivered	% LGAC Ingested
Argentina (CONAE)	COA	TM	TM
		ETM+	ETM+
Australia (GA-NEO)	ASA	MSS	MSS
		TM	TM
		ETM+	ETM+
Australia (GA-NEO)	HOA	TM	TM
		ETM+	ETM+
Brazil (INPE)	CUB	MSS	MSS
		TM	TM
		ETM+	ETM+
Canada (CCMEO)	GNC	MSS	MSS
		TM	TM
		ETM+	ETM+
Canada (CCMEO)	PAC	MSS	MSS
		TM	TM
		ETM+	ETM+

- In process data delivery from Argentina (LTOs)
- Brazil – MSS HDDTs
 - 1st set of sample HDDTs was unsuccessful, investigating second set of tapes
 - ~875 tapes waiting at Brazil to be sent

LGAC Status

Country (Organization)	Ground Station	% LGAC Delivered	% LGAC Ingested
China (RADI)	BJC	<div><div>TM</div></div>	<div><div>TM</div></div>
		<div><div>ETM+</div></div>	<div><div>ETM+</div></div>
China (RADI)	KHC	<div><div>TM</div></div>	<div><div>TM</div></div>
Ecuador (IEE)	CPE	<div><div>TM</div></div>	<div><div>TM</div></div>
Europe (ESA)	FUI	<div><div>MSS</div></div>	<div><div>MSS</div></div>
		<div><div>TM</div></div>	<div><div>TM</div></div>
		<div><div>ETM+</div></div>	<div><div>ETM+</div></div>
Europe (ESA)	KIS	<div><div>MSS</div></div>	<div><div>MSS</div></div>
		<div><div>TM</div></div>	<div><div>TM</div></div>
		<div><div>ETM+</div></div>	<div><div>ETM+</div></div>
Europe (ESA)	MTI	<div><div>TM</div></div>	<div><div>TM</div></div>
		<div><div>ETM+</div></div>	<div><div>ETM+</div></div>
Europe (ESA)	NSG	<div><div>ETM+</div></div>	<div><div>ETM+</div></div>
India (NRSA)	SGI	<div><div>MSS</div></div>	<div><div>MSS</div></div>
		<div><div>TM</div></div>	<div><div>TM</div></div>
Indonesia (LAPAN)	DKI	<div><div>TM</div></div>	<div><div>TM</div></div>
		<div><div>ETM+</div></div>	<div><div>ETM+</div></div>

- In process data delivery from China (electronic), Ecuador (DLTs) and Europe (USB HDs)
 - Europe is reprocessing all data allowing EROS to ingest raw data during reprocessing
 - Finish Kiruna (KIS) then work other stations
 - Issues with missing PCD with about 500,000 TM scenes
 - ♦ Ability to ingest resolved
 - ♦ Working on production capability
- Agreement with India is in-work.
 - Exchange real-time L7 downlinks
 - Test downlinks provided and ground processing being worked by India

LGAC Status

Country (Organization)	Ground Station	% LGAC Delivered	% LGAC Ingested
Japan (HIT/HEEIC)	HIJ	ETM+	ETM+
Japan (JAXA/RESTEC)	HAJ	MSS	MSS
		TM	TM
		ETM+	ETM+
Kyrgyzstan (DLR)	BIK	TM	TM
Mongolia (DLR)	ULM	TM	TM
Pakistan (SUPARCO)	ISP	TM	TM
Saudi Arabia (KACST)	RSA	MSS	MSS
		TM	TM
South Africa (SANSA)	JSA	MSS	MSS
		TM	TM
		ETM+	ETM+
Taiwan (CSRSR-NCU)	CLT	TM	TM
Thailand (GISTDA)	BKT	MSS	MSS
		TM	TM
		ETM+	ETM+
US (U of Puerto Rico)	UPR	ETM+	ETM+

- In process data delivery from Saudi Arabia (HDDTs) and South Africa (electronic)
- Verbal commitment from Thailand GISTDA Executive Director during May 13, 2014 EROS visit. On GISTDA executive board meeting August 1, 2014

Technical Barriers

- Recovery of old data is a challenge! E.g. 2x bake->clean->read
- Brazil (INPE) – HDDT drive loaned to USGS (lower left)
- USGS Legacy drives (center)
- 2,540 Pakistan HDDTs (lower right)
- Parts sent from IC stations (upper right)



Remaining Work

- **Receive a copy of all Landsat data from ICs that have not yet delivered data or have not yet agreed to participate**
- **Complete ingest of all data received**
- **Continued system improvements to produce L1Ts**
- **Develop additional MSS data format converters**
 - ♦ Many different format types
 - ♦ Handling of partially processed data
- **Continue to refine process for reading data off of old media**
 - ♦ HDDTs
 - ♦ DCRSi tapes

Key Data Production Improvements

Item	Additional Information	Status
Integration of new cloud mask algorithm (fmask)	TM, ETM+, and OLI/TIRS	In work – Winter 2014/2015
Ground Control Chip (GCP) library updates Phase I	177 Path/Row combinations improved	Fall 2014 (Markham)
GCP Phase II	Low-latitude areas	Winter 2014/2015
GCP Phase III	High-latitude areas	Follows Phase II
Pseudo-invariant calibration image assessment enhancements	Further automates the generation of average radiance values for any vicarious cal site	Completed Feb 2014
TIRS bias adjustment and L8 data reprocessing	Initial updates and reprocessing. Larger update in work (Markham)	Completed – March 2014
ETM+ Level-1 Systematic Terrain Fallback	Fall back to terrain corrected systematic when precision ground control can't be applied	Analysis in work; system capability exists.



Key Data Production Improvements

Item	Additional Information	Status
Increase product distribution space	Increase distribution space by 2x!	Fall 2014
ESA TM 'missing PCD' data ingest	Updates to legacy LACS system to ingest select LGAC TM scenes (affects ~ 500,000 scenes)	In work – Summer 2014
Level 1 data format study	More flexible alternatives to gzip'd L1T	Study wrapping up, requires feedback, no implementation planned at this time
TOA Reflectance (L1-7 consistency w/L8)	Reflectance scaling factors (multiplicative and additive) which are scene based coefficients in mtl file for L1-7 (no sun angle correction)	Winter 2014/2015
TOA Reflectance Enhanced Metadata	Scene-specific per-pixel solar azimuth and sensor viewing angle enhanced metadata to allow users to convert to reflectance	Winter 2014/2015, TM/ETM+ follows OLI/TIRS

Data Improvements In Queue

Item	Additional Information	Status / Plan
Quality Band (L1-7, potential updates to L8)	Define quality band for each sensor (MSS, TM, ETM+). Potential updates to OLI/TIRS	Started – Science Feedback
TIRS Ghosting	Being worked by cal team	? (Markham)
Land-based cloud cover score	Calculate CCA on land-only - provide in metadata / user search	Spring 2015
Landsat DEM Improvement	Augment or replace existing GLS2000 DEM	Study in queue, USGS Topo project
Product ‘versioning’ updates	Improve data so users can more readily determine changes in the product	Need a plan - science feedback

Check LMWS for Product Updates

<http://landsat.usgs.gov>

USGS
science for a changing world

Landsat Missions

Search...

Home

Mission Headlines

October 21, 2013 - Upcoming Landsat 8 Reprocessing
Within the next several weeks, all Landsat 8 data that have been acquired since achieving WRS-2 operational orbit will be reprocessed using updated calibration parameters for OLI and TIRS data. During this time, all online products will be purged and the online inventory will be re-populated. Details about the reprocessing effort and expected duration will be posted on this site when they become available.

October 17, 2013 - Landsat Data Processing Resumes
Processing has resumed for Landsat 8 and Landsat 7 data acquired from October 1, 2013 to October 17, 2013. Scenes will become available for download from [EarthExplorer](#) and [GloVis](#) as processing is completed.

Get Data

View and Get Color Images - [LandsatLook Viewer](#)
Browse and Download Data - [GloVis](#)
Search and Bulk-Download Data - [EarthExplorer](#)

Landsat 8 Data Available!
Data collected by the Operational Land Imager (OLI) and the Thermal Infrared Sensor (TIRS) instruments aboard Landsat 8 are available to download from [EarthExplorer](#), [GloVis](#), and the [LandsatLook Viewer](#).

Image of the Week

Andasol Solar Power Stations

USGS



Product Improvements - TOA Reflectance

- **First Release - Reflectance Rescaling Coefficients in Metadata (MSS, TM, ETM+)**
 - Reflectance scaling factors (multiplicative and additive) which are scene based coefficients in mtl file for L1-7 (no sun angle correction)
 - Conversion to TOA Reflectance explained at http://landsat.usgs.gov/Landsat8_Using_Product.php
- **Second Release – Enhanced Metadata / Angle Coefficient File**
 - Landsat OLI/TIRS
 - ♦ Scene-specific per-pixel solar azimuth and sensor viewing angle coefficient file
 - Allows users to perform per-pixel correction when converting to reflectance
 - ♦ Will provide a tool to access data to build angle bands
 - Landsat TM/ETM+
 - ♦ Concept is similar to L8; analysis in work

Product Improvements Quality Band / CFMASK

- **Landsat 1-7 Quality Band Definition**
 - **TM and ETM+**
 - ♦ Cloud/shadow content from cfmask
 - ♦ 'No-data' / quality from SLC-Off for ETM+
 - ♦ Saturated Pixels
 - **MSS**
 - ♦ Saturated Pixels
 - ♦ 'No-data' mask
- **Landsat 8 Quality Band Refinement**
 - cfmask replaces cloud/shadow content
 - Other improvements / updates (defer to John)

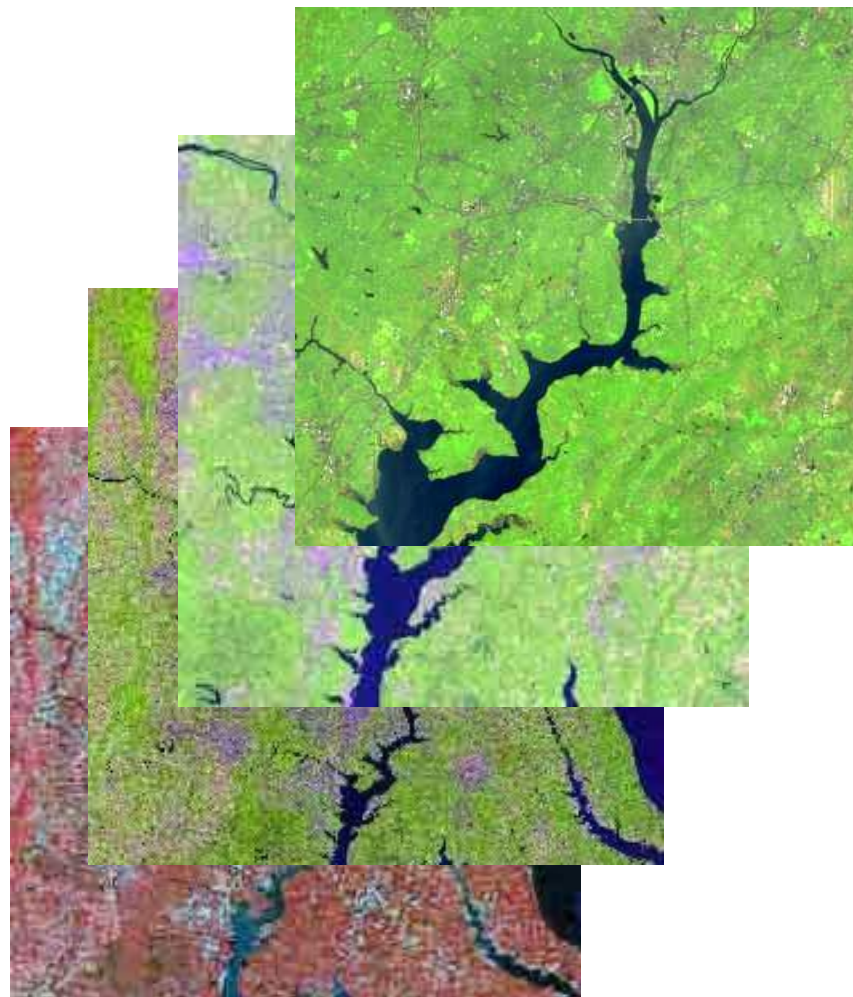
Level 1 Data Format Study

- **Level-1 products are GeoTIFF format compressed into single file using UNIX tar and zip functions**
 - Efficient for storage and distribution over the network
 - Users must uncompress and untar downloaded data before use
 - Users are requesting selection of band-specific data for their application purposes
 - Not feasible for some immediate access services (OGC services)
- **USGS is performing a study to analyze product format alternatives and plans to produce product samples**
 - Given magnitude of data, compression is highly desirable
 - Looking at: 1) GeoTiff w/compression 2) HDF5 w/compression 3) JPEG2000 w/compression
- **Plan to solicit science feedback**
 - Preliminary results are favoring JPEG2000

U.S. Landsat Archive Overview

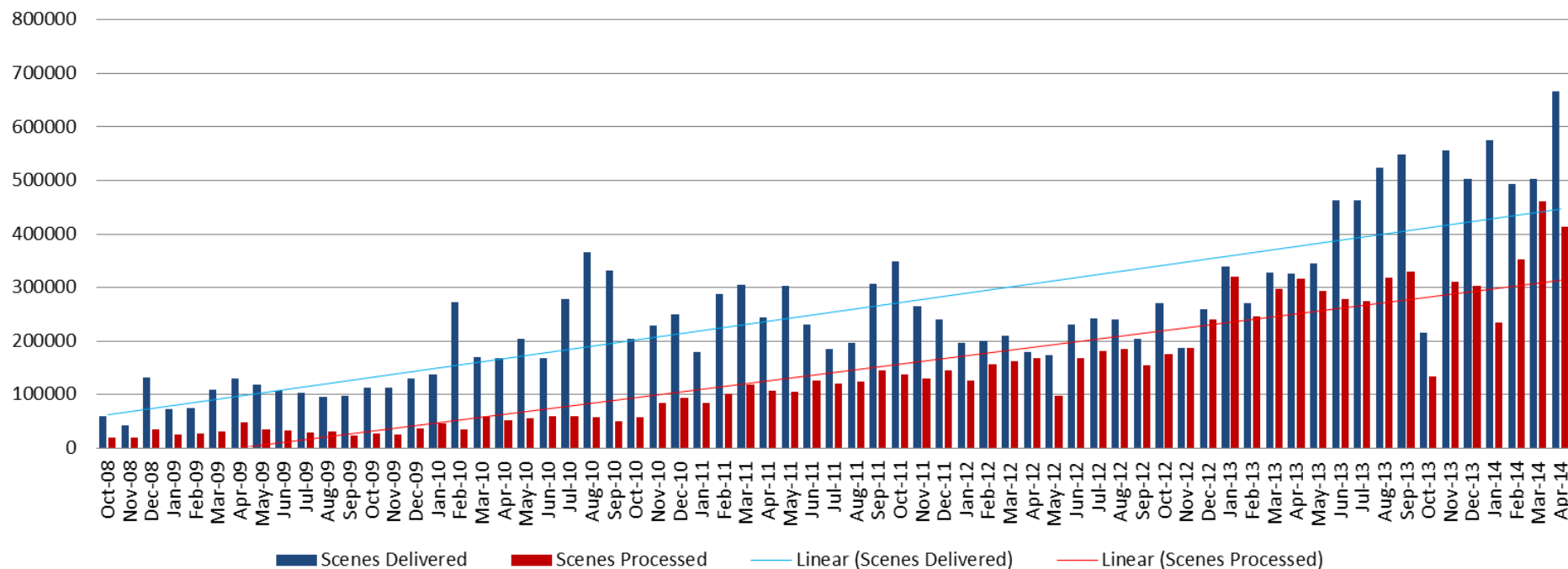
(July 1, 2014)

- **OLI-TIRS: Landsat 8**
 - 252,440 scenes
 - ♦ ~ 872 TB Raw and L0Ra Data
 - average scene size 1813 MB
- **ETM+: Landsat 7**
 - 1,766,142 scenes
 - ♦ ~ 1,640 TB Raw and L0Ra Data
 - average scene size 487 MB
- **TM: Landsat 4 & Landsat 5**
 - 1,941,390 scenes
 - ♦ ~ 973 TB Raw and L0Ra Data
 - average scene size 263 MB
- **MSS: Landsat 1 through 5**
 - 1,314,377 scenes
 - ♦ ~ 80 TB Raw and L0Ra Data
 - average scene size 32 MB
- **Total:**
 - 5,274,349 scenes
 - ♦ ~ 3,565 TB Raw and L0Ra Data



Monthly Downloads / Processed

Landsat Web-Enabled Monthly Statistics



FY09

Delivered: 1.14M
Processed: 358K

FY10

Delivered: 2.45M
Processed: 567K

FY11

Delivered: 2.92M
Processed: 1.27M

FY12

Delivered: 2.73M
Processed: 1.82M

FY13

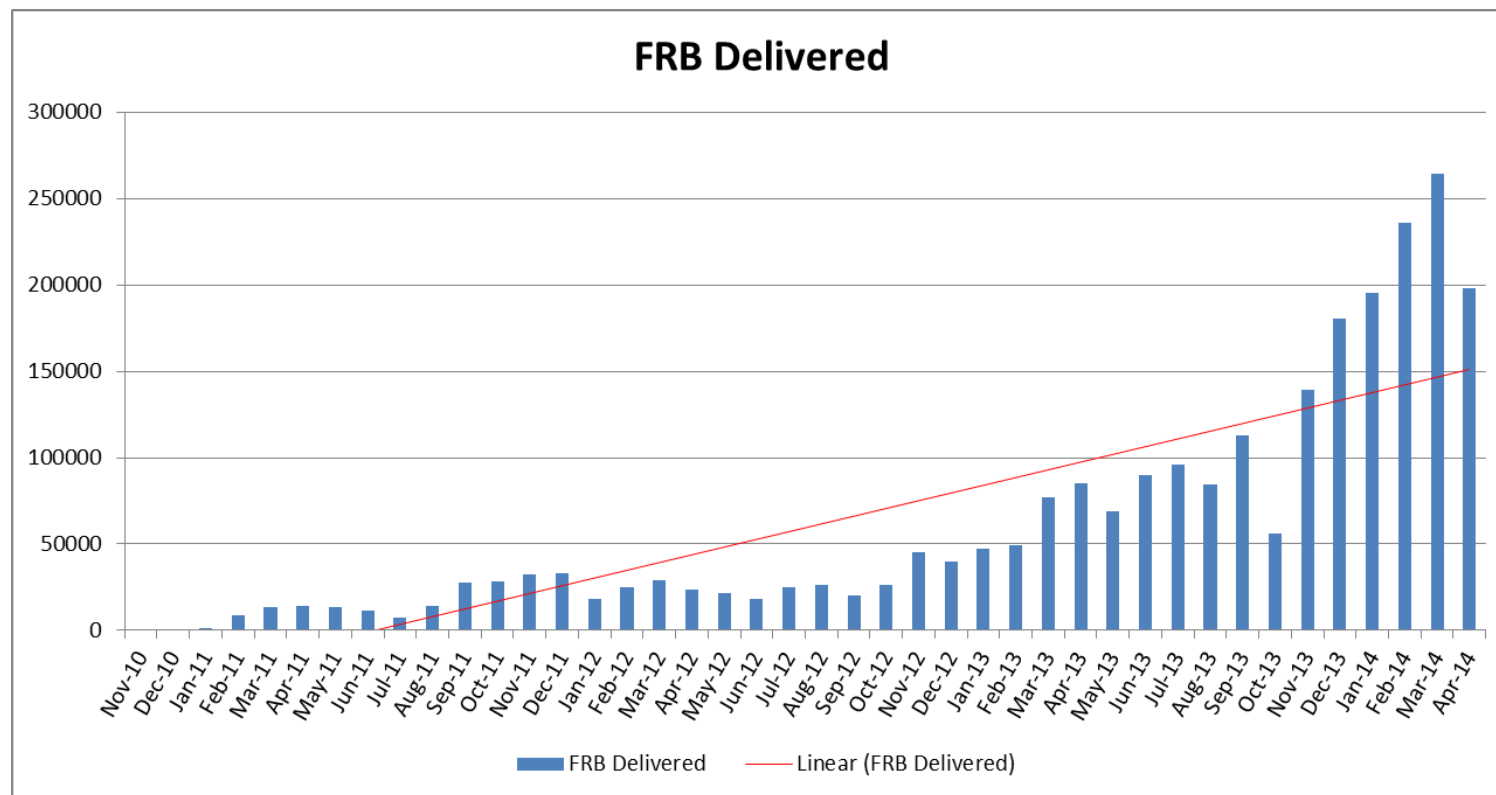
Delivered: 4.32M
Processed: 3.28M

FY14 (Sep-Apr)

Delivered: 3.51M
Processed: 2.21M



Monthly Full Resolution Browse Downloads



FY11 (Oct '10–Sep '11)

Delivered: 112K

FY12 (Oct '11–Sep '12)

Delivered: 301K

FY13 (Oct '12–Sep '13)

Delivered: 823K

FY14 (Oct '13–Apr '14)

Delivered: 1,270K



Questions?

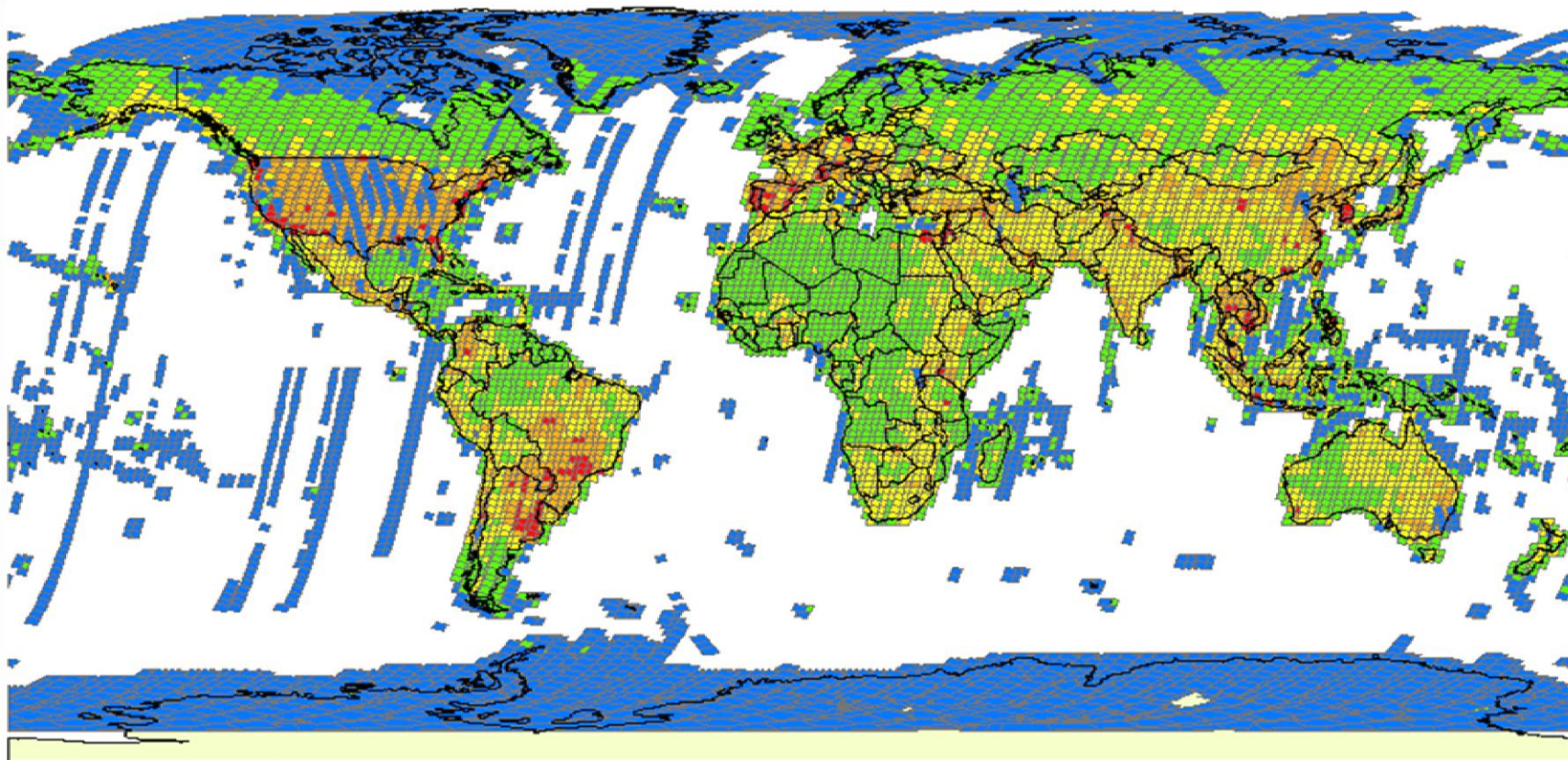


Additional Information

Statistics

- **All statistics generated for the period of October 2013 through April 2014**

OLI / TIRS Downloads

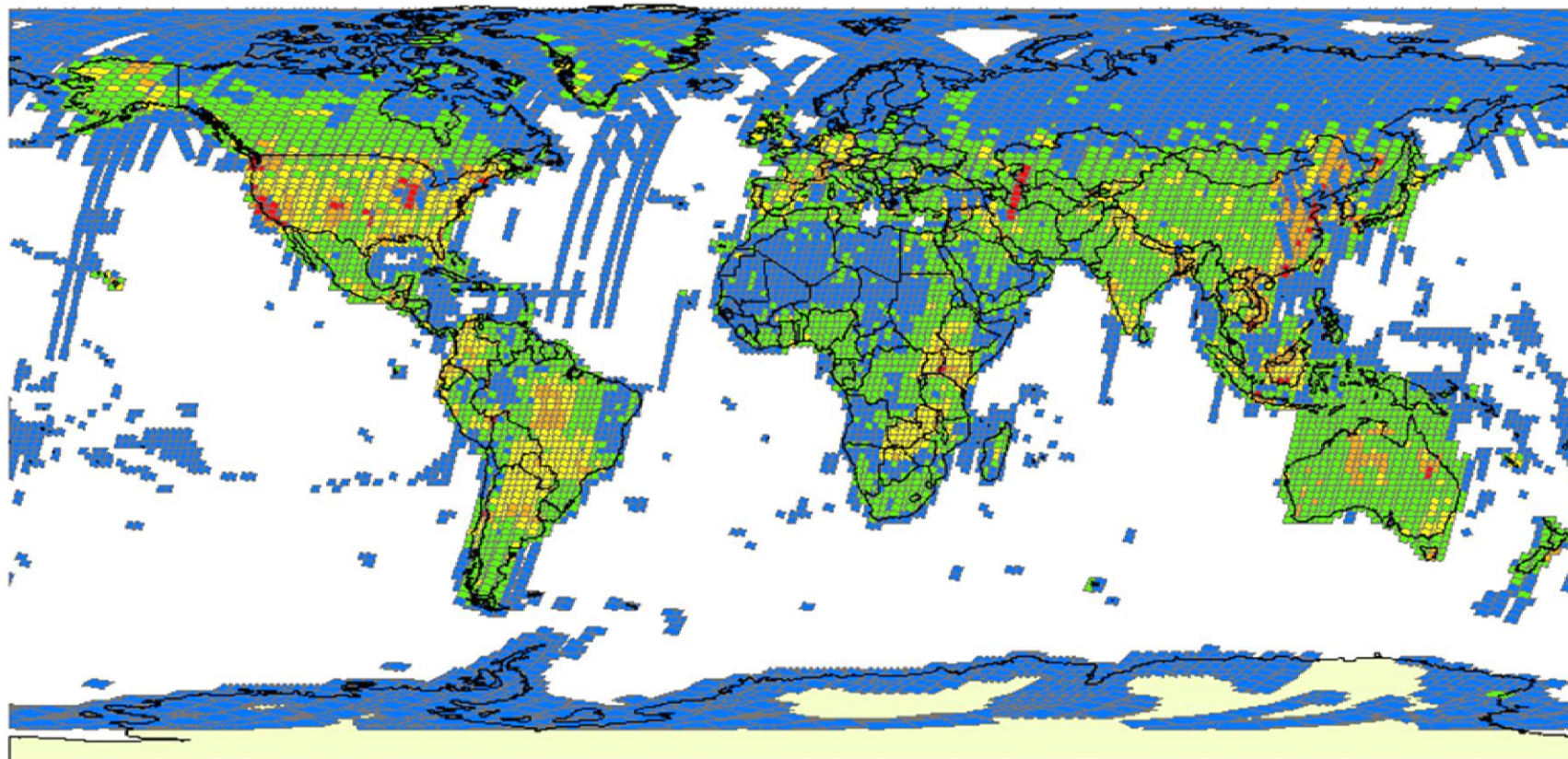


OLI & TIRS Standard Product Downloads
via User Interface and Bulk Users
October 01, 2013 through April 30, 2014
3,263,192 Total Cumulative Scenes Delivered
887,632 Total OLI & TIRS Scenes Delivered
16,148 Unique OLI & TIRS Locations

1 - 36 37 - 86 87 - 146 147 - 246 247 - 621



ETM+ Downloads

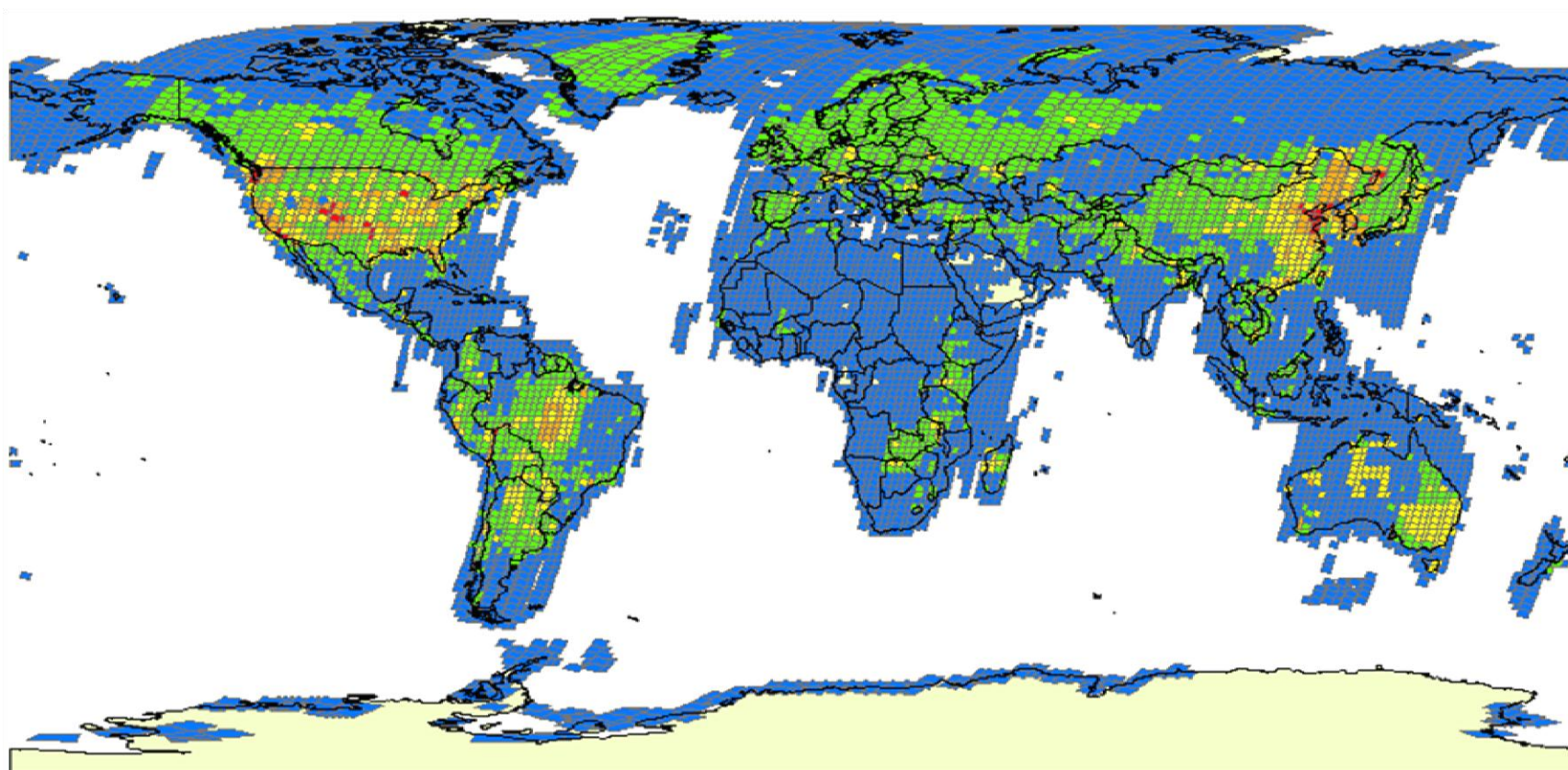


ETM+ Standard Product Downloads
via User Interface and Bulk Users
October 01, 2013 through April 30, 2014
3,263,192 Total Cumulative Scenes Delivered
936,322 Total ETM+ Scenes Delivered
13,965 Unique ETM+ Locations

1 - 50 51 - 144 145 - 311 312 - 610 611 - 1338



TM Downloads

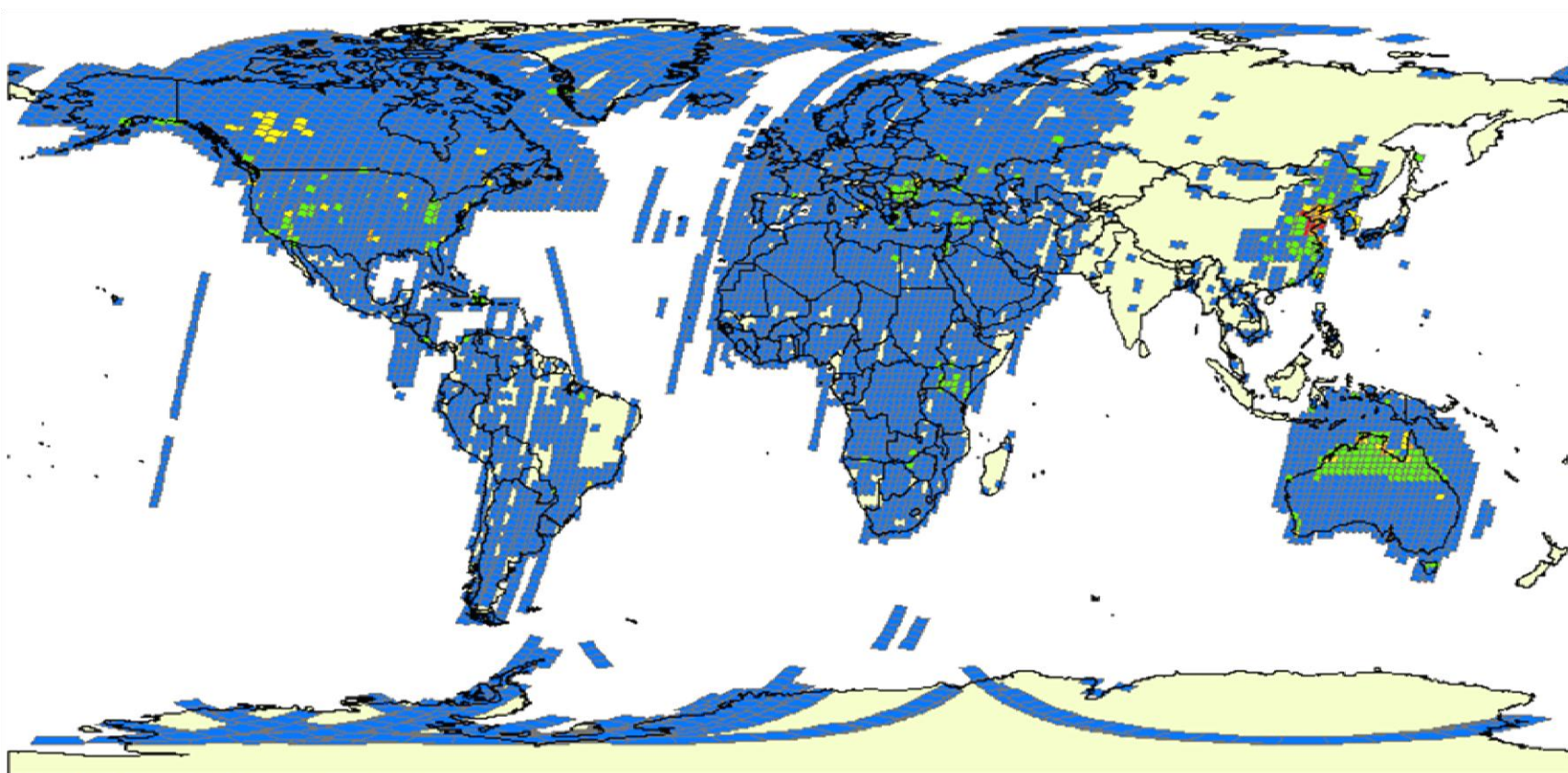


TM Standard Product Downloads
via User Interface and Bulk Users
October 01, 2013 through April 30, 2014
3,263,192 Total Cumulative Scenes Delivered
916,647 Total TM Scenes Delivered
11,347 Unique TM Locations

1 - 71 72 - 219 220 - 513 514 - 1024 1025 - 2273



MSS WRS-2 Downloads

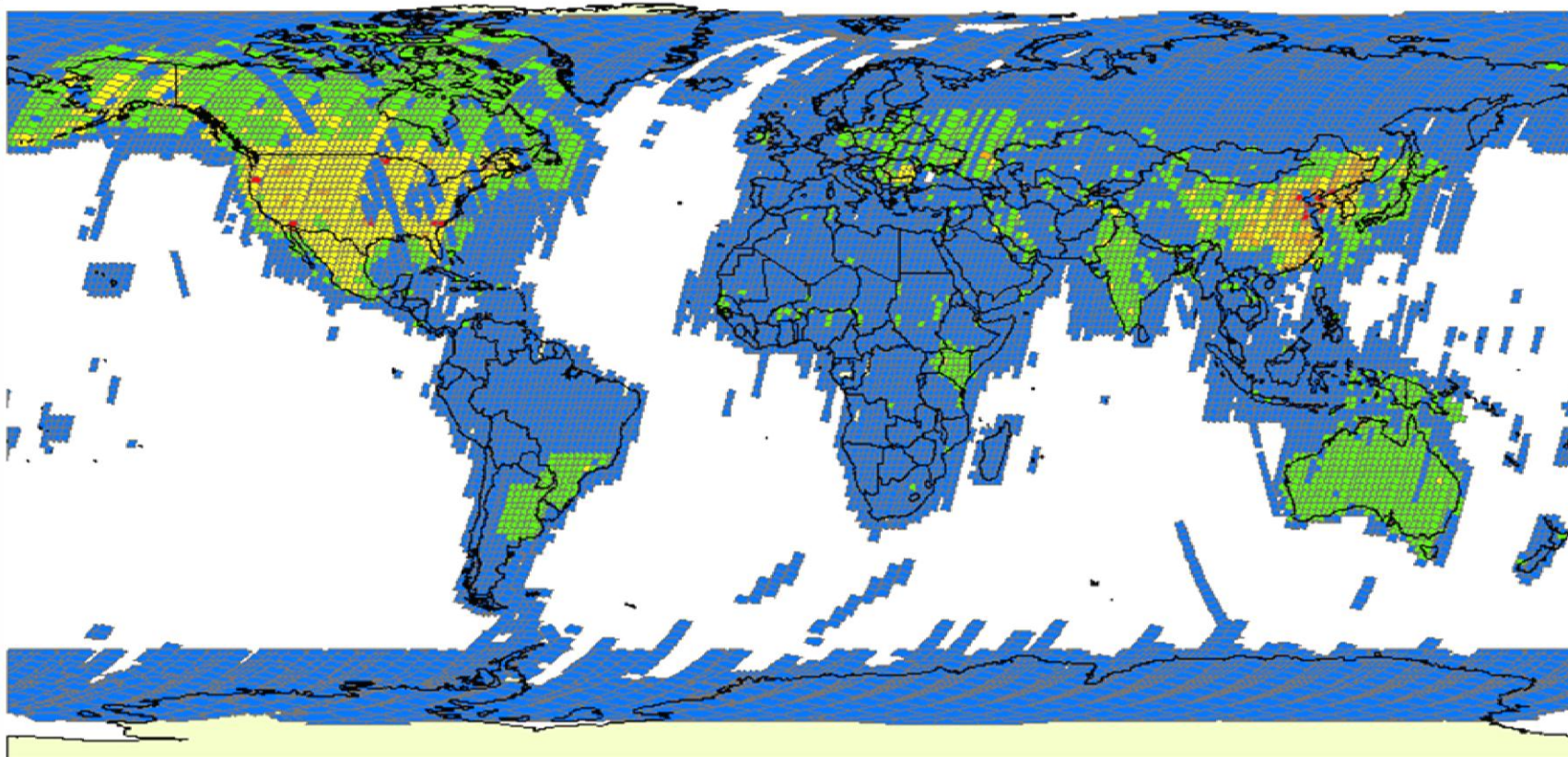


MSS WRS2 Standard Product Downloads
via User Interface and Bulk Users
October 01, 2013 through April 30, 2014
3,263,192 Total Cumulative Scenes Delivered
126,957 Total MSS WRS2 Scenes Delivered
6,924 Unique MSS WRS2 Locations

1 - 39 40 - 177 178 - 615 616 - 1515 1516 - 2679



MSS WRS-1 Downloads



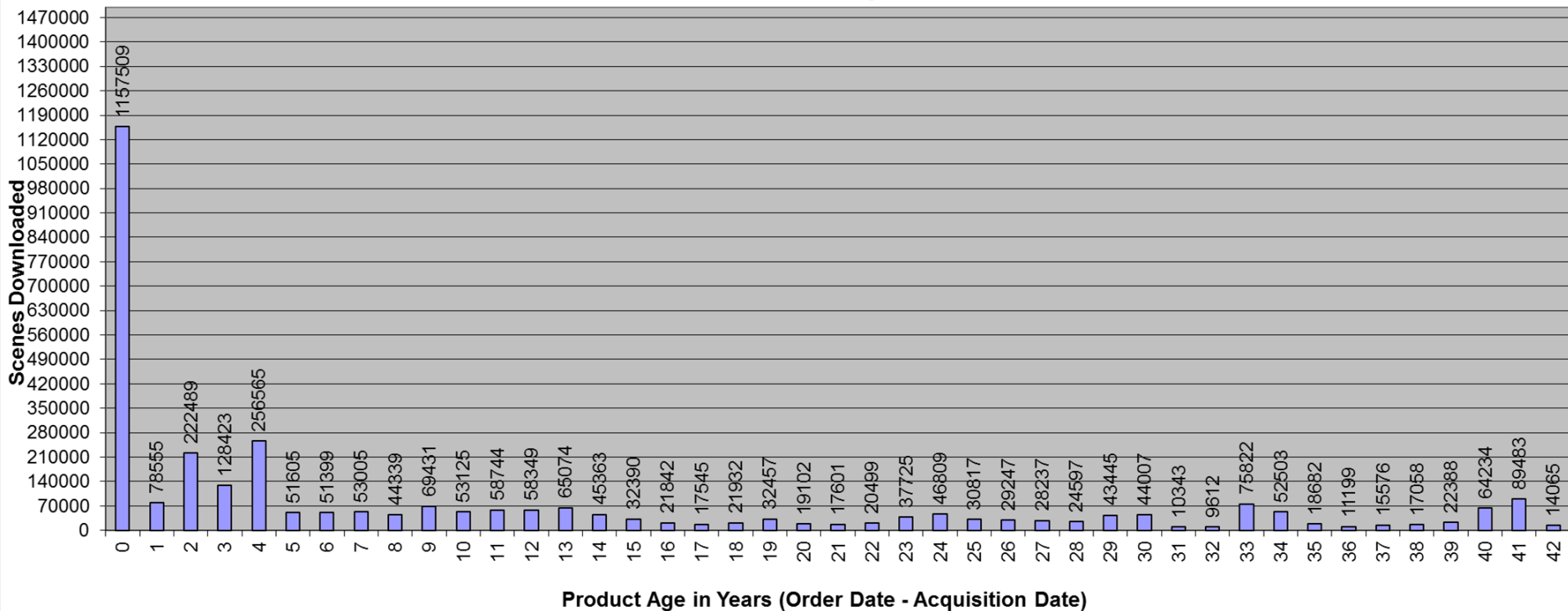
MSS WRS1 Standard Product Downloads
via User Interface and Bulk Users
October 01, 2013 through April 30, 2014
3,263,192 Total Cumulative Scenes Delivered
395,634 Total MSS WRS1 Scenes Delivered
15,971 Unique MSS WRS1 Locations

1 - 29 30 - 90 91 - 217 218 - 482 483 - 1128

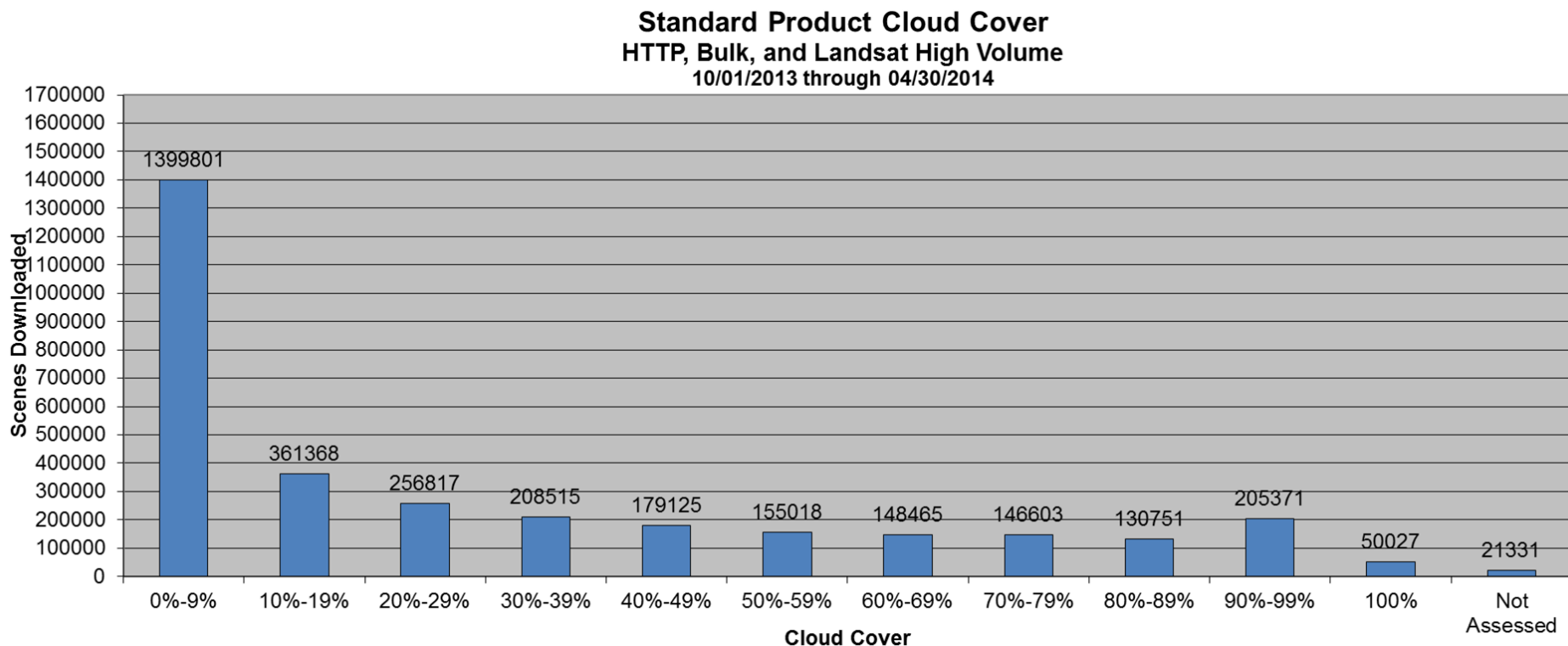


Age of Scenes Downloaded (yearly)

Standard Product Age
HTTP, Bulk, and Landsat High Volume
10/01/2013 through 04/30/2014

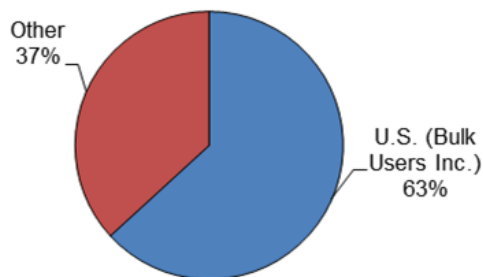


Cloud Cover of Scenes Downloaded

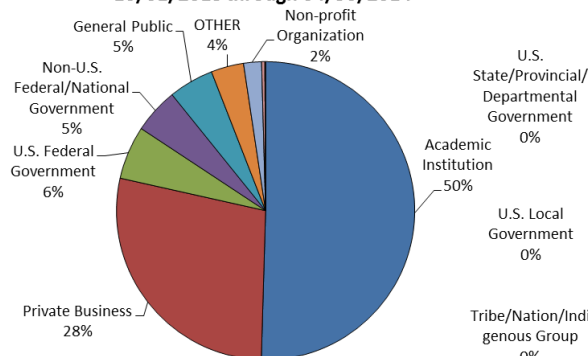


Landsat Distribution Customer Demographics (Oct 2013 – Apr 2014)

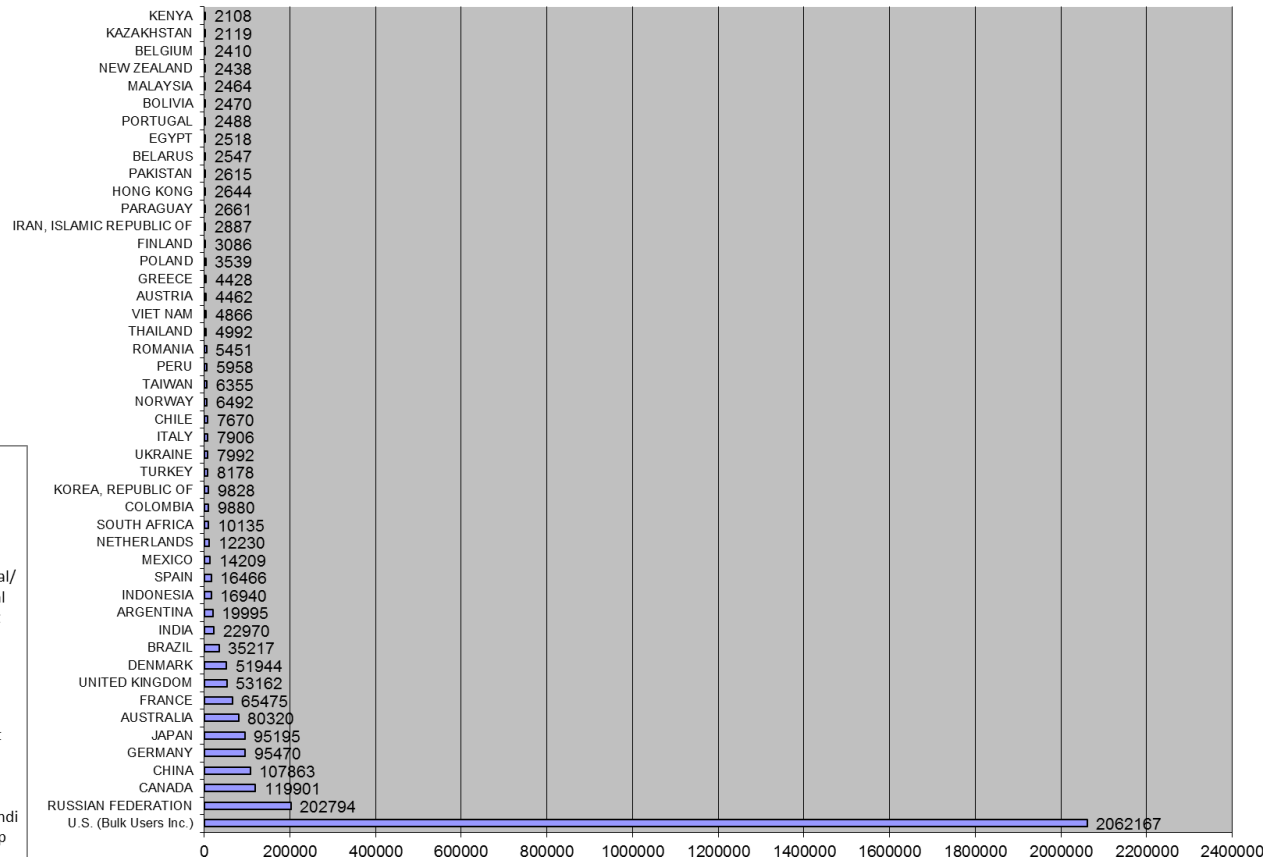
StdL1T Downloads by Country
10/01/2013 through 4/30/14



User Affiliations of Landsat Data
10/01/2013 through 04/30/2014

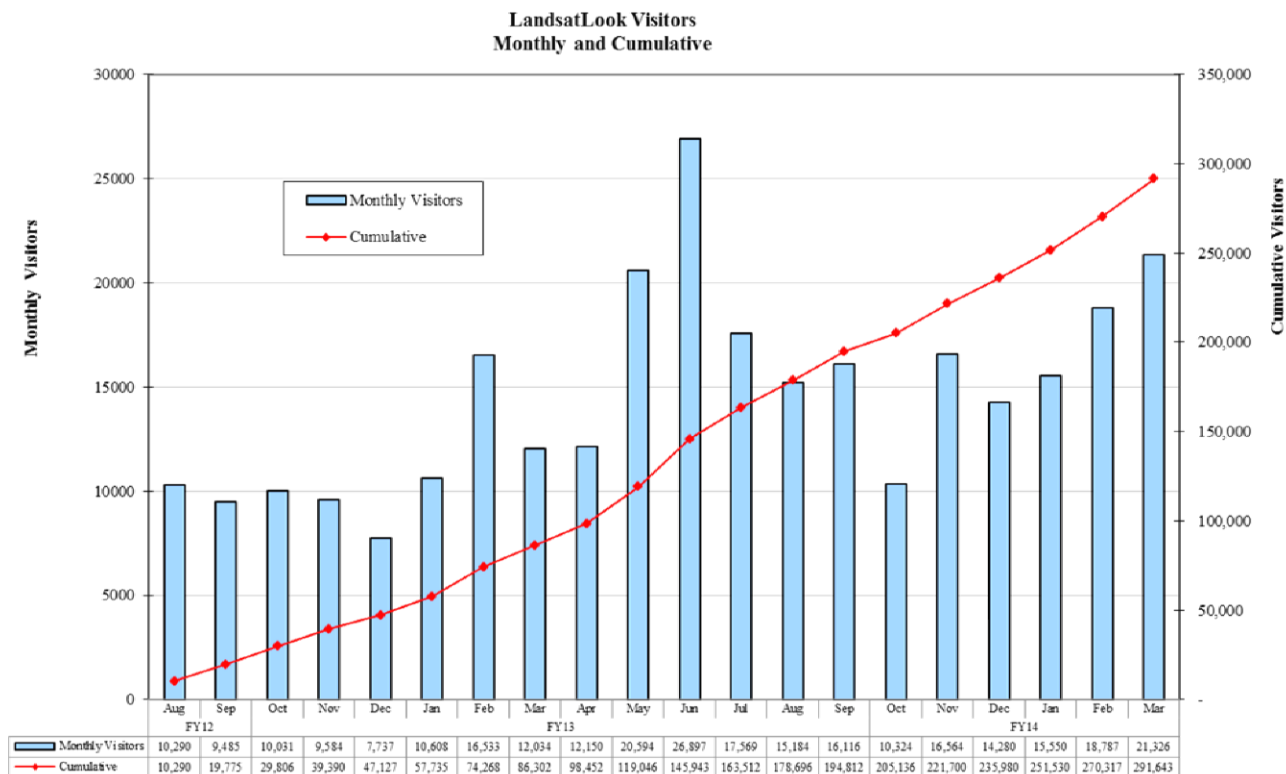


Standard Product Downloads by Country
(Countries with >2000 Scenes Downloaded)
10/01/2013 through 04/30/2014



Full-Resolution Browse Statistics

	Country	Visitors	% of Total Visitors
1	United States	6,957	38.09%
2	China	1,381	7.56%
3	Russian Federation	886	4.85%
4	Unknown	721	3.95%
5	Japan	713	3.90%
6	Argentina	570	3.12%
7	India	525	2.87%
8	Brazil	467	2.56%
9	Indonesia	466	2.55%
10	Germany	432	2.37%
11	Australia	417	2.28%
12	Canada	328	1.80%
13	United Kingdom	297	1.63%
14	Mexico	183	1.00%
15	Netherlands	154	0.84%
16	Malaysia	150	0.82%
17	Italy	150	0.82%
18	Colombia	144	0.79%
19	France	134	0.73%
20	Iran	131	0.72%



Single Gyro Control

- USGS continues effort to develop a system capable of controlling the satellite with only 1 functioning gyro (the satellite currently needs 2)
- 3 Phases of Development
 - Phase 1 - develop an immediate response to move away from the current orbital slot in the event that another gyro is lost to operations. This plan expires upon the completion of Phase 2a. **Completed 1 Jul 2004**
 - Phase 2a - develop the capability to control the spacecraft in a safe mode with only 1 operational gyro. **Completed 1 Feb 2006**
 - Phase 2b - develop the capability to slew and maneuver the spacecraft with only 1 operational gyro. **Completed Aug 2007**
 - Phase 3 - develop the capability to conduct imaging operations with only 1 operational gyro. **In work (initial concept was too intensive for on-board CPU, new version in work. Algorithms were re-developed and simplified where possible. Coding of FSW is now under way to assess viability of the patch on the 1750A processor and develop FSW loads for implementation of new control system)**



Payload Performance and Anomalies

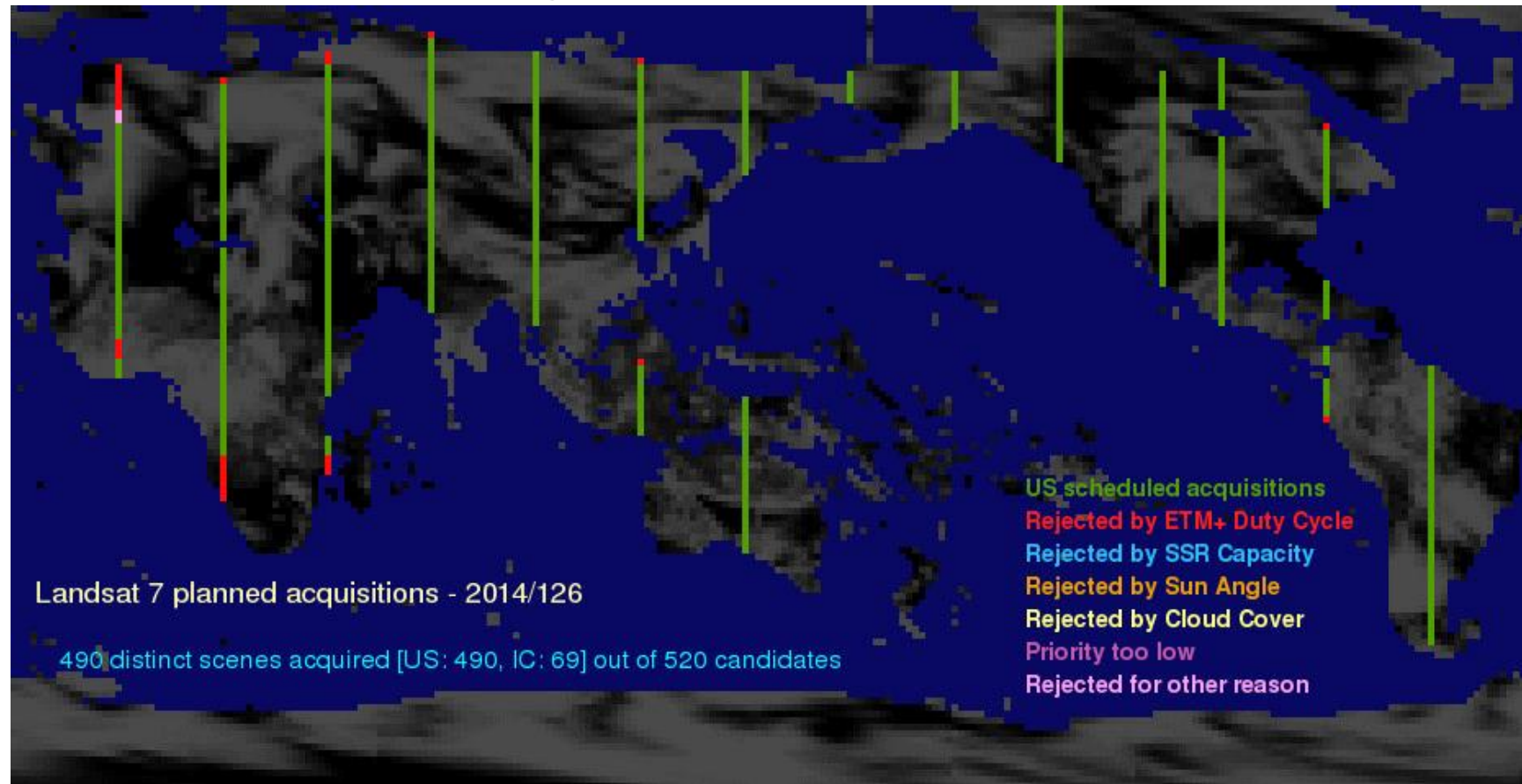
15 Nov 1999 - SSR PWA #23 failure
26 Apr 2000 - GXA - ETM+ interaction discovered
11 Feb 2001 - SSR PWA #12 failure
14 May 2002 - EPS Circuit #14 failure
31 Jul 2002 - Gyro 3 motor current spikes
24 Oct 2002 - ETM+ Scan Mirror stops during imaging
31 May 2003 - ETM+ SLC malfunction*
04 Sep 2003 - PDF - FSW timing conflict
05 May 2004 - Gyro 3 Shut down
24 Feb 2005 - RCS Primary heater circuit disabled
16 May 2005 - EPS Circuit #6 failure*
15 Jun 2005 - First of several reduced gyro FSW loads
07 Dec 2005 - SSR PWA #2 failure
01 Feb 2006 - Reduced gyro phase IIa complete
01 Apr 2007 - Switched to ETM+ Bumper mode
28 Mar 2008 - SSR PWA #22 failure
13 Aug 2008 - EPS Circuit #14 recovery
03 Sep 2008 - SSR PWA #23 recovery
25 Apr 2013 - RCS Redundant heater circuit disabled
12 Oct 2013 - SSR PWA #11 failure

* Represents a permanent loss of redundancy and/or capability



Constraints Influence Landsat 7 Seasonal Coverage

- Daily limits are removed
- If duty cycle constraints are relaxed, they usually convert to SSR constraints
- To increase acquisitions, more ground contacts are required



Landsat 8 – Reject reasons

- Daily maps with rejection reasons since 29 April
- Graph of rejection

